VOL. 45 DECEMBER 1918 NO. 12

GENERAL LIBRARY
DEC 24 1918
UNIV. OF MICH.
SCIENCE LIBRARY

BULLETIN

OF THE

TORREY BOTANICAL CLUB

Editor

ALEXANDER WILLIAM EVANS

Associate Editors

JEAN BROADHURST
JAMES ARTHUR HARRIS
MARSHALL AVERY HOWE
MICHAEL LEVINE
WILLIAM GEORGE MARQUETTE
ARLOW BURDETTE STOUT
NORMAN TAYLOR

CONTENTS

Notes on plants of the northern United States—IV.
FRANCIS W. PENNELL 477

The strand flora of the Hawaiian Archipelago—II. Ecological relations.
VAUGHAN MACCAUGHEY 483

INDEX TO AMERICAN BOTANICAL LITERATURE. 503

INDEX TO VOLUME 45 511

PUBLISHED FOR THE CLUB
THE NEW ERA PRINTING COMPANY
LANCASTER, PA.

THE TORREY BOTANICAL CLUB

President

HERBERT M. RICHARDS, Sc.D.

Vice-Presidents

JOHN HENDLEY BARNHART, A.M., M.D.
C. STUART GAGER, PH.D.

Secretary and Treasurer

BERNARD O. DODGE, PH.D.
Dept. of Botany, Columbia University
New York City

MEETINGS

Meetings twice each month from October to May inclusive: the second Tuesday at 8:00 P.M., at the American Museum of Natural History; the last Wednesday at 3:30 P.M., in the Museum Building of the New York Botanical Garden.

PUBLICATIONS

All subscriptions and other business communications relating to the publications of the Club should be addressed to the Treasurer, Dr. Bernard O. Dodge, Dept. of Botany, Columbia University, New York City.

Bulletin. Monthly, established 1870. Price, $4.00 a year; single numbers 40 cents. Of former volumes, only 24–43 can be supplied separately; certain numbers of other volumes are available, but the entire stock of some numbers has been reserved for the completion of sets. Manuscripts intended for publication in the BULLETIN should be addressed to the Editor, Osborn Botanical Laboratory, Yale University, New Haven, Connecticut. Papers should not exceed twenty pages in length, and illustrations (other than zinc etchings) should be limited to one page of half tones or one plate for each ten pages of text. Longer and more copiously illustrated papers, however, may be published if the excess pages and illustrations are paid for by the contributors.

Torreya. Monthly, established 1901. Price, $1.00 a year. Manuscripts intended for publication in TORREYA should be addressed to Norman Taylor, Editor, Brooklyn Botanic Garden, Brooklyn, N. Y.

Memoirs. Occasional, established 1889. (See last pages of cover.)

Preliminary Catalogue of Anthophyta and Pteridophyta within 100 miles of New York City, 1888. Price, $1.00

Reprints. Contributors of articles accepted for publication in the BULLETIN should order reprints, if desired, when they return galley proof to the editor. 25 copies of reprints without cover may be had gratis. If cover is wanted, or if more than 25 copies are wanted, they may be ordered through the editor at the following rates from The New Era Printing Co., Lancaster, Pa., contributor paying for all his reprints.

	2pp	4pp	8pp	12pp	16pp	20pp
25 copies	$ .79	$1.14	$1.78	$2.32	$2.87	$3.28
50 copies	1.03	1.43	2.23	2.82	3.52	3.92
100 copies	1.45	2.03	2.73	3.50	4.23	4.55
200 copies	2.15	3.24	3.92	5.25	6.52	6.92

Covers: 25 for $1.00, additional covers 1¼ cent each.
Plates for reprints, 50 cents each per 100.

Vol. 45. No. 12

BULLETIN

OF THE

TORREY BOTANICAL CLUB

DECEMBER, 1918

Notes on plants of the southern United States—IV

FRANCIS W. PENNELL

THE GENUS CROTONOPSIS

In 1803 Michaux published in his "Flora Boreali-Americana" a new genus of plants to which, from its evident likeness to *Croton*, he gave the name of *Crotonopsis*. The genus has been maintained continuously from that time, although twice have attempts been made to rechristen it. In 1826 Sprengel, without comment, proposed to substitute *Friesia*, and twelve years later Rafinesque, remarking that "the name previously given was absurd and incorrect," announced his *Leptemon*. According to current rules of nomenclature *Crotonopsis* must be held.

Michaux collected *Crotonopsis* twice, and, in the plate which accompanies the description of his species *C. linearis*, he fortunately figured both the specimens obtained. The drawing to the left hand shows a low plant with lanceolate or elliptic-lanceolate leaves and with fruits few and axillary, that to the right is of a side-branch of a taller plant with narrower longer leaves and with conspicuously elongated spikes. Two localities are cited in the text, Long-bay, Carolina, and the Illinois region. From evidence to be presented it is clear that two species are illustrated, and, from the form of its leaves, that to the right is the one entitled to the name *C. linearis*. Fortunately it is also that from the locality first cited. True *C. linearis* Michx. is a plant restricted to the Coastal Plain of the southeastern states.

[The BULLETIN for November (45: 433–476, *pl. 13–15*) was issued November 15, 1918.]

In 1805, but two years later, Willdenow added a second species, *Crotonopsis elliptica*. His plant is stated to differ from the linear-leaved *C. linearis* Michx. in its leaves being elliptic, rounded to each end, and in its spikes being shorter. Evidently *C. elliptica* is our oldest name for the widely-ranging northern and inland species. As this plant extends to the Gulf coast, incidentally overlapping the range of *C. linearis*, the type-region, "Carolina," is well within its normal range.

The later history of the genus may be briefly sketched. Pursh in 1814 combined both species, though as varieties, in one, his *C. argentea*. Nearly to the close of the past century the genus was uniformly considered monotypic. But in 1895 Nash, from a single collection from Florida, added a second species, *C. spinosa*. As a matter of fact he was actually recharacterizing Michaux's *C. linearis*, laying primary emphasis upon newly discovered features of the fruit.

Spikes short, of but one or two fruits. Staminate flowers less than 1 mm. in diameter; filaments shorter than the sepals, and but little longer than the anthers. Fruit ovoid, with an evident median vein on each side; scale-like hairs on fruit with broad brown disk, umbonate to tuberculate-raised, even occasionally into a short spine, and with its margin of relatively uniform closely appressed white rays. Leaves lanceolate to ovate-lanceolate, 1.5–3 cm. long; stellate hairs on upper surface with long rays which overlap those of adjoining hairs. Plant usually 1–5 dm. tall. 1. *C. elliptica.*

Spikes longer, slender, of three to six fruits. Staminate flowers more than 1 mm. in diameter; filaments longer than the sepals, and much longer than the anthers. Fruit ellipsoid, without evident vein on the side; scale-like hairs on fruit with minute disk, which is usually raised into a decided tubercle or spine, and with long irregular stellate not closely appressed slightly brownish rays. Leaves lanceolate-linear, 2–4 cm. long; stellate hairs on upper surface with short rays which do not overlap those of adjoining hairs. Plant usually 4–8 dm. tall. 2. *C. linearis.*

1. CROTONOPSIS ELLIPTICA Willd.

Crotonopsis elliptica Willd. Sp. Pl. 4: 380. 1805. "Habitat in Carolina."

Crotonopsis argentea elliptica Pursh, Fl. Am. Sept. 1: 206. 1814.

Dry sandy soil, Connecticut to northern Florida, west to eastern Kansas and central Texas; northward in or near the Coastal Plain, southward mostly inland, on granitic rocks of the Piedmont and southern Appalachian regions. Numerous specimens seen. The most southwestern studied are from sandy post-

oak woods, Sheridan, Colorado County, Texas, my number *5533*, and are unique in that the plants were uniformly 7–8 dm. tall, and the fruit relatively large and somewhat brownish instead of being nearly black.

2. CROTONOPSIS LINEARIS Michx.

Crotonopsis linearis Michx. Fl. Bor. Am. **2**: 186. *pl. 46* p.p. 1803. "*Hab.* in maritimis Carolinae, juxta *Long-Bay*, et in regione Illinoensi." Two plants figured. One is a plant with lanceolate-linear leaves and slender spikes, the other with lanceolate to ovate-lanceolate leaves and flowers one to two together. As Illinois specimen certainly the latter, and as the former is known in the maritime region of Carolina, and is the plant to which the name *linearis* better applies, this is selected as the type.

Crotonopsis argentea Pursh, Fl. Am. Sept. **1**: 206. 1814. Consists of two varieties; name is here applied to first.

Crotonopsis argentea linearis Pursh, *l. c.*

Friesia argentea Spreng. Syst. **3**: 850. 1826. Without citation of Pursh.

Leptemon lineare Raf. Sylva Tellur. 67. 1838.

Crotonopsis spinosa Nash, Bull. Torrey Club **22**: 157. 1895. "Collected by Mr. W. T. Swingle [*1397a*] at Dunellon [Florida], July 24 [1894]." Type seen in the herbarium of Columbia University at the New York Botanical Garden.

Dry sandy soil, in the Coastal Plain, South Carolina to central Florida and eastern Texas, extending inland near the Mississippi River to southern Illinois and southeastern Missouri, and in Texas to Dallas.

SOUTH CAROLINA. Beaufort: Bluffton, *Mellichamp* (M). Charleston: Mt. Pleasant, *L. R. Gibbes* (Y).

GEORGIA. Lowndes: Olympia, *R. M. Harper 1593* (M, U, Y). Mitchell: *R. M. Harper 1168* (M, U, Y).

FLORIDA. Baker: Macclenay, *L. H. Lighthipe 586* (Y). Brevard: Melbourne, *Curtiss 5715* (M, U, Y). Escambia: Pensacola, *J. M. Macfarlane* (P). Hillsboro: Tampa, *A. P. Garber* (U). Jefferson: *Hitchcock* (M). Lake: Eustis, *Nash 1971* (M, U, Y). Leon: Tallahassee, *N. K. Berg* (Y). Marion: Dunnellon,

Swingle 1397a (U, Y). Orange: *A. Fredholm 5389* (Y). Pinellas: Ozona, *F. L. Lewton* (Y). St. John: St. Augustine, *M. C. Reynolds* (P). Sumter: Wildwood, *H. J. Webber* (M). Suwanee: Live Oak, *Curtiss 6897* (M, U, Y).

MISSISSIPPI. Oktibbeha: Starkville, *S. M. Tracy* (M).

ILLINOIS. Mason: "sandy barrens," *E. Hall* (M).

MISSOURI. Dunklin: Campbell, *Bush* (M). Stoddard: *Bush 124* (Y).

TEXAS. Dallas: Dallas, *Reverchon 869* (M, Y), *3177* (M), *4366* (M, U). Waller: Hempstead, *E. Hall 575* p.p. (M, U, Y).

MISCELLANEOUS RECORDS

HYPERICUM OPACUM T. & G.

Collected in flower August 15, 1912, in moist long-leaf pineland, Ozone Park, St. Tammany Parish, Louisiana, my number *4216*.

LECHEA LEGGETTII Britton & Hollick

Collected in fruit August 14, 1912, in dry open long-leaf pineland, Abita Springs, St. Tammany Parish, Louisiana, my number *4162*. Wide-spread through the southeastern states, reaching Florida and Louisiana.

RHEXIA LUTEA Walt.

Collected in fruit August 14, 1912, in moist long-leaf pineland, Abita Springs, Louisiana, my number *4198*.

RHEXIA NASHII Small

Collected in flower August 16, 1912, moist sandy soil near Mandeville, St. Tammany Parish, Louisiana, my number *4239*. Through the long-leaf pineland of the Coastal Plain, North Carolina to Florida and Louisiana. When seen living, readily distinguished from *R. mariana* L. by its flowers, the petals of which are much larger, 18–25 mm. long, and deep purple-pink.

Rhexia interior Pennell, nom. nov.

Rhexia latifolia Bush, Rhodora 13: 167. 1911. Not *Rhexia latifolia* Aubl. Pl. Gui. 1: 336. 1775. Aublet's plant is not retained in the genus *Rhexia* as today understood, a fact which

under the Vienna Code permits the repetition of the same specific name.

Collected in fruit September 8, 1913, moist shady soil, west of Sapulpa, Creek County, Oklahoma, my number *5389*.

The following key to the species of *Rhexia* is offered:

Anthers relatively short, oblong, straight, not spurred at base.
Petals yellow. Leaves lanceolate. 1. *R. tulea* Walt.
Petals pink-purple. Leaves ovate.
Hypanthium glabrous. Upper surface of the leaves hirsute. 2. *R. petiolata* Walt.
Hypanthium glandular-hirsute. Upper surface of the leaves glabrous. 3. *R. serrulata* Nutt.
Anthers longer, linear, curved, spurred at the base.
Anther-sacs very slightly spurred. Petals less than 10 mm. long, white. 4. *R. parviflora* Chapm.
Anther-sacs evidently spurred. Petals more than 10 mm. long, pale pink (or white in *R. lanceolata*) to pink-purple.
Leaves membranous, green; lateral nerves not close to the margin; upper surface of some or all leaves hirsute. Hypanthium glandular-hirsute to glabrous.
Apex of hypanthium not lanose. Calyx-lobes less than one-third length of hypanthium.
Stem obscurely if at all winged, internodes conspicuously hirsute.
Leaves narrowed at base. Neck of hypanthium equaling or but slightly shorter than the body.
Petals pale-pink to white, 10–15 mm. long. Buds with sepal tips mostly spreading-recurved.
Leaves elliptic-ovate to lanceolate, all evidently three-veined, mostly over 2 cm. long, the lower with a more or less petiolar base.
Leaves elliptic-ovate, on evident petioles 3–4 mm. long. Petals about 10 mm. long. 5. *R. delicatula* Small.
Leaves lanceolate to elliptic-lanceolate, on ill-defined petioles. Petals 12–15 mm. long. 6. *R. mariana* L.
Leaves narrowly lanceolate to linear, only the main stem-leaves if any three-veined, mostly less than 2 cm. long, sessile. Petals 10–12 mm. long. 7. *R. lanceolata* Walt.
Petals deep purple-pink. Buds with sepal-tips mostly ascending-appressed.
Petals 18–25 mm. long. Hypanthium 10–14 mm. long, its neck equaling the body. Stem obscurely angled.
Leaves linear, sparsely hirsute, lateral nerves obscure. 8. *R. cubensis* Griseb.

Leaves lanceolate, conspicuously hirsute, lateral nerves prominent. 9. *R. Nashii* Small.

Petals 10–14 mm. long. Hypanthium 7–8 mm. long, its neck slightly shorter than the body. Stem relatively sharply angled. 10. *R. interior* Pennell.

Stem conspicuously wing-angled, the internodes sparsely hirsute to glabrous. Leaves rounded at base, the upper clasping. Neck of hypanthium much shorter than the body. Petals deep purple-pink.

Internodes of stem sparsely hirsute. Leaves ovate. Hypanthium hirsute. 11. *R. virginica* L.

Internodes of stem glabrous. Leaves ovate-lanceolate. Hypanthium sparsely glandular-pubescent to glabrous. 12. *R. stricta* Pursh.

Apex of hypanthium lanose with glandless yellow hairs. Calyx-lobes more than one-half length of hypanthium. 13. *R. aristosa* Britton.

Leaves firm, glaucescent, lateral nerves following closely the margin of the blade; upper surface glabrous. Hypanthium densely glandular-pubescent. 14. *R. Alifanus* Walt.

RAIMANNIA DRUMMONDII (Hook.) Rose

Collected in flower October 12, 1912; beachs and, Sullivan Island, Charleston County, South Carolina, my number *4857*. Extensively spreading from Texas along the coastal dunes of the southeastern states.

MYRIOPHYLLUM PROSERPINACOIDES Gill.

Pool in long-leaf pine-land, Mandeville, St. Tammany Parish, Lousiana, my number *4205*. Established also in ditches at Houma, Terre Bonne Parish. Naturalized from Chile.

The strand flora of the Hawaiian Archipelago—II. Ecological relations

VAUGHAN MACCAUGHEY

TEMPERATURE

The Hawaiian littoral zone is characterized by relatively warm and uniform thermal conditions throughout the year. Sudden fluctuations are exceedingly rare and are never of great magnitude. The lowest recorded littoral temperature is 47° F., the highest is 98° F.; the mean of all littoral temperatures is 74° F. The mean monthly temperature at Honolulu, which may be taken as a representative coastal station, varies from about 70.5° F. to 76.8° F., in January and July respectively.

The following table, arranged from data of the Hawaiian Section, U. S. Weather Bureau, will show the temperature conditions (for 1915) of a number of littoral stations on the various islands. Data are not available from more strictly littoral stations—i. e., at the actual beach line itself. This is a problem that awaits future field investigation.

Station		Elevation in feet	Temperature		
			Mean	Max.	Min.
KAUAI:	Mana	30	73.9°	93°	51°
	Kealia	15	73.1	88	47
OAHU	Kahuku	25	76.6	88	60
	Honolulu	111	75.0	87	58
	U. S. Mag. Sta.	45	75.5	92	50
	Waianae	6	76.2	93	52
	Waialua Mill	30	74.3	93	52
MOLOKAI:	Kalawao	70	75.2	90	57
MAUI:	Kaanapali	12	72.8	91	55
	Hana	145	75.6	89	58
HAWAII:	Mahukona	11	75.5	98	58
	Niulii	200	73.5	87	58
	Pepeekeo	100	73.3	86	57
	Hilo	100	72.6	87	54
	Kapoho	110	72.8	89	58

Olsson-Seffer ('10) presents data to show that on tropical and subtropical coasts the variations in the temperature of sea-water are mainly due to changes in the direction of the winds and cur-

rents. Close to the shore, or where the water is shallow, the temperature of the water is higher when the surface is calm, but low when the sea is rough. This is the natural consequence of the solar radiation in the former case, and of the mixing by the waves of the surface water with the cooler water from below when the sea is disturbed.

The annual thermal ranges of the oceanic waters of four representative regions will make a significant contrast with the conditions prevailing in Hawaiian waters: Sydney Harbor, Australia, 55.8°–72.4° F.; San Francisco Bay, California, 42°–69° F.; Woods Hole, Massachusetts, below freezing–70° F.; Plymouth, England, 44.1°–58.9° F.

The great oceanic current from the northeast, which travels down the Pacific Coast and out past Hawaii, as part of the Equatorial Drift, has so profound an effect upon the Hawaiian climate in general and the littoral zone in particular, that it merits special consideration here. Dr. Sereno O. Bishop, who made Hawaii his home for many years, writes ('04) of this current, as follows:

> That remarkable stream of cold water, which flows in a vast stream southerly, skirting southeast Alaska, Vancouver's Island, the Pacific States of Washington, Oregon, and California, and finally passes out westward to Hawaii, beyond which group it becomes merged into the great equatorial current running westward.
>
> This stream is of very low temperature, of immense volume, and of great velocity. It is unique in its powerful effects upon the climates of the coasts along which it flows. . . . Finally turning westward like the trade winds under the impulse of the earth's rotation, this mighty stream broadens out into the open ocean, gradually gaining warmth.

Dall ('04) states:

> As it moves down the coast it loses its heat and produces the rain and fogs of the Oregonian region, cooling off so that when it reaches the latitude of the Golden Gate it has only the temperature of 54° or thereabouts, and is colder than the normal seawater for that latitude. It continues southward as a cold current, as described by Dr. Bishop. After traversing 2,200 miles it reaches the Hawaiian Islands, still at the low temperature of 70° in late summer, and of below 60° in late winter. This imparts to that favored group a uniformly subtropical climate such as is unknown to any other land in the same latitude.

Cowles, in describing the strand of the Lake Michigan dune region ('99; p. 107), states that on the beach, due to the "absence of vegetation and the general exposure . . . the temperature is higher in summer and lower in winter than in most localities. This great divergence between the temperature extremes is still

further increased by the low specific heat of sand." This is also true of the Hawaiian sand strands. There is a greater temperature range on the beach itself than in the protected zone lying immediately behind the beach. However, the temperature range of the littoral is insignificant when contrasted with that of the mountains that ascend directly from the lowlands, and in many places directly from the littoral. The diurnal range in temperature increases as one ascends the mountain slopes, and this range reaches its maximum on the high summits of Kea and Loa (nearly 14,000 ft.). Guppy ('03–'06) found the mean daily range of temperature on the summit of Loa, August, 1897, to be 30.6° F.; the lowest reading was 15°, the highest 61.2°.

Although sand has low specific heat, the upper dry layer becomes excessively hot under a cloudless sky. Cockayne ('11) records surface temperatures of 120°–127° F. on the New Zealand strand; these figures are even higher than the generalization made by Guppy in the table given below. It should be noted, however, that the wet underlayers of sand absorb heat much more slowly. At the depth of a few inches below the surface the sand is always moist, so that the roots of sand-strand plants descend very quickly into relatively cool soil.

Guppy ('03–'06) makes the following generalizations concerning beach temperatures, the data applying to ordinary beaches under an unclouded sky, in the hot season, during the early afternoon:

		Surface—half-inch deep	Four inches deep
Temperate	about 50°–55° lat.	100°–105° F.	77° F.
Subtropical	" 30 –35 "	105 –110	80
Tropical	" 10 –20 "	110 –120	85

Olsson-Seffer ('09, pp. 88, 89) gives an extensive series of strand temperatures secured by him in various parts of the world.

With reference to temperature, Hawaiian strand regions may be classified as follows:

I. Warmer strands—leeward, facing SE., S., or SW.

1. Typical leeward beaches: e. g., Mana, Barber's Point, leeward Molokai, Lahaina, and Kawaihae.
2. Slope approaches plane perpendicular to incident sunlight: flat beaches, like those of Midway, Laysan, leeward Kauai and Puna.

3. Not subjected to shadows: as for 2.
4. Heat reflected by neighboring objects: e. g., Mana dune strand, Koko Head tufa cliff coast, Mokapu.
5. Composed of dark materials which absorb and retain heat: lava beaches of Hawaii, Maui, and parts of Oahu and Kauai.
6. Texture unfavorable for rapid evaporation of moisture: mud beaches and tufa cliff beaches, e. g., Pearl Harbor Inlet and Mokapu.
7. Arid or semiarid: not receiving the cooling effects of rain, waterfalls, etc., e. g., southwestern coasts of Maui and Hawaii.

II. Cooler strands—windward, facing NE., N., or NW.

8. All of the windward beaches.
9. Slope more or less precipitous: high beaches, e. g., Hamakua coast, windward East Molokai, Napali and Nihoa.

Illumination

The brilliant illumination of the Hawaiian strand is one of its most distinctive ecological features. The intense light of open beaches as contrasted with other regions, has been commented upon by ecologists in various parts of the world, but nowhere is this better exemplified than in the Hawaiian Islands. On the low islands the sky is cloudless, except during the infrequent rains. On the high islands the clouds heap over the mountainous interior, leaving the peripheral strand zone almost continuously exposed. The total insolation, in diurnal or in annual terms, is therefore exceedingly high. The Hawaiian coast, with its excessive insolation, may be contrasted, for example, with the gray, foggy coast of Washington and Oregon. On the coral and tufa beaches the intensity of the direct illumination is greatly increased by reflection. The glare on a coral beach, during the middle part of the day, as almost as intolerable to the eyes as that from a snow-field.

There are few data as to the direct and indirect effects of excessive insolation, save as an integral part of the xerophyte-producing complex. In general, light retards growth, and too great an intensity of light causes cessation of the growth of an organ. Pfeffer ('03, p. 87) states:

The internodes become shorter and the plant more condensed as the intensity of the light increases, while the leaves attain their maximal size at a certain medium intensity of illumination. This latter is owing to the fact that moderate light stimulates the growth of the leaves, whereas intense light retards it.

Jost ('07, p. 125) makes the following statements:

We are not accurately acquainted with the precise way in which assimilation is dependent upon the intensity of light. All researches agree on one point, viz., that assimilation of carbon is approximately proportional in amount to the intensity of light; it is questionable, however, whether this is the rule with higher intensities . . . it may be easily imagined that a further increase in assimilation, following on increase in light, is impossible owing to the deficiency in carbon-dioxide. Carbon-dioxide may be present in sufficient quantity under ordinary circumstances to employ all the energy of sunlight, but when light is artificially increased the usual amount of carbon dioxide would constitute a sub-optimum.

Schimper ('03, p. 58) states as a result of excess light;

Terrestrial plants . . . frequently suffer from a considerable disintegration of their chlorophyll. The vegetation of very sunny spots is never pure green, but always exhibits an admixture of yellow and brown tints due to the products of decomposition of chlorophyll . . . intense tropical light may even completely bleach the foliage.

Many of the Hawaiian beach plants are grayish or yellowish green. This is characteristic, not only of Hawaii, but also of other strands. As Cockayne ('11) suggests:

The yellow colour of certain dune plants belonging to different unrelated families is doubtless correlated with excess of light, and seems to me a possible example of heredity of an acquired character.

The author cannot share the latter view, as beach plants which have happened to grow in the shade develop normal green pigment, instead of the bleached beach pigment. Such species as *Santalum Freycenetianum* var. *littorale*, *Lepidium owaihense*, *Euphorbia cordata*, *Batis maritima*, *Argyreia tiliaefolia*, and *Cressa cretica* furnish excellent examples of this pronounced difference between the sun leaves and shade leaves of littoral plants.

A further comparison may be made which will illustrate the intensity of the strand illumination. In the rain-forest and summit-bog zones, and in the deep ravines of the lower and middle forests, the ordinary illumination on cloudy days—and these are regions of almost continuous cloudiness—necessitates a photographic exposure of say three minutes, whereas the same subject, distance, and aperture on the strand would require but one seventy-fifth of a second. The difference in illumination indi-

cated by these figures is thus about 13,500, that is, the beach illumination is approximately 13,500 times as great as that of the cloudy rain-forest. Of course, these figures do not include all of the light-factors involved, but they are sufficient to indicate the great differences in the illumination of regions not far removed from one another.

Precipitation

All precipitation on the Hawaiian littoral occurs in the form of rain, dew, and rarely hail; snow is unknown. The strand is characteristically xerophytic or semi-xerophytic, as contrasted with the mesophytic lowland areas, and the montane rain-forests. The following data from representative stations of the U. S. Weather Bureau, 1915, will show these differences, the amount of rainfall being given in inches:

Island	Littoral station	Mesophytic station	Hygrophytic station
Kauai	16.98	38.02	75.52
Oahu	18.99	42.29	114.22
Maui (1914)	20.91	42.70	397.26
Hawaii	8.41	39.10	159.60

A few littoral stations are mesophytic or hygrophytic, but this is a relatively unusual condition—e. g., Na Pali coast of Kauai, north coast of East Molokai, and Hamakua coast of Hawaii.

The relationship between the annual precipitation on the strand and the character of the vegetation is very close. The paucity of the Hawaiian arborescent strand flora is undoubtedly due in part to the xerophytic character of the littoral. In those few strand regions which do possess sufficient rainfall, the forest extends down to the beachline. The Puna, Hilo, and Hamakua regions, illustrate this condition. Schimper ('03, p. 407) makes the generalization:

> Open littoral formations occur throughout the tropics, and in districts with a small rainfall they are almost the only ones. The close woodland above high-tide mark and the mangrove growing within reach of the tide are luxuriantly developed only in districts with abundant rain; and as the atmospheric precipitations decrease they become lower in stature, less close, and poorer in species.

In the case of the Hawaiian littoral vegetation, much emphasis must be laid upon the exterminating and limiting agencies which

have been introduced into the islands within historic times. The ravages of wild live-stock, such as cattle, goats, sheep, and swine; the clearing of the lowlands for agricultural and other purposes; the building of roads; the large quantities of firewood which were drawn from the nearest and most easily available sources; the introduction of a great variety of pernicious foreign weeds—all of these factors have contributed largely to the depletion of the lowland and littoral floras, and have given them an aspect of meagerness that they probably did not possess in their primitive state. Man and his domestic animals have been much more potent limiting factors than has been precipitation.

WIND ACTION

The wind is a powerful agency in its direct mechanical effects upon beach vegetation. Many strand plants have forms that are more or less protective, i. e., prostrate, creeping, rosette, or hemispherical aerial bodies. Plants of upright habit are permanently deflected and shaped by the wind; the windward branches are stunted and warped, and growth takes place chiefly on the leeward side of the plant. Seaside plants of *Acacia farnensiana*, *Prosopis juliflora*, *Santalum Freycinetianum* var. *littorale*, *Calophyllum inophyllum*, and *Kadua littorale* commonly illustrate this condition. These wind-beaten plants are invariably dwarfed.

The mechanical effect of the wind is greatly augmented on those coasts upon which it is able to pick up quantities of beach sand. At storm times, in such regions, the wind becomes a veritable sand-blast. The evidences of this sand-blast action, upon the trunks of both living and dead trees, and upon the local topography itself, are familiar to all who have travelled along a windy coast. The fantastic sculpturing of the seaward slopes of tufa in the Koko Head region, and at Mokapu Peninsula, admirably illustrate this sand-blast work. The herbaceous vegetation on these slopes is either prostrate or rosette, e. g., *Sesuvium Portulacastrum*, *Argyreia tiliaefolia*, *Boerhaavia diffusa;* or tough and wiry, e. g., *Sporobolus virginicus*, *Fimbristylis pycnocephala*.

On the Hawaiian littoral the wind is not as important an ecologic agent as in such a region as the Lake Michigan sand dunes. Here, according to Cowles ('99, p. 108), it "is the chief destroyer

of plant societies," acting in two ways—either by undermining plant individuals and groups, or by burying them with dune sand. Neither of these processes is particularly conspicuous along Hawaiian coasts; the vegetation is not sufficiently luxuriant to emphasize the former, nor are the dunes of sufficient size or mobility to give much importance to the latter. Here and there, however, both of these processes may be witnessed.

On the whole, the Hawaiian beach winds are retarding rather than destructive agencies. The Hawaiian strands may be divided into the following classes, based upon the relative exposure to wind action:

1. *Shores exposed to prevailing winds.*—The windward strands are much more exposed than are those along the leeward sides of the islands. Excellent contrasts are: the Hamakua and South Kona shores of Hawaii; the northeast and southwest shores of Haleakala; the north and south coasts of East Molokai; the Koolau and Waianae shores of Oahu; the Kilauea and Kekaha shores of Kauai.

2. *High or promontory-like shores.*—These are more exposed than are low flat shores. Good examples are: Hamakua, Hawaii; Hana and Kaanapali, Maui; the great pali of Molokai; Makapuu and Kaena, Oahu; Napali, Kauai; and the cliffs of Nihoa.

3. *Shores devoid of surface irregularities or vegetation sufficient to break the force of the wind.*—Low, flat shores, not protected by mountains behind them nor covered with forest, are exposed to the full force of the wind. In this class belong the coral atolls, and such shores as Kahuku and Mokapu, Oahu, the western extremity of Molokai, the Maui isthmus, and the extreme south point of Hawaii.

Transpiration

This is unquestionably the most important single physiological factor in determining the character of the Hawaiian strand flora. Only those plants which possess comparatively low transpiratory rates are able to permanently establish themselves upon the strand. Those species which invade the strand from the interior, and are characteristically mesophytic, undergo marked structural changes when they appear as members of the strand association.

The importance of the evaporation factor, particularly in the early stages of an association, is admirably emphasized by Transeau ('08, p. 230), who states:

> The greatest decrease in the demands for transpiration on the part of seedlings takes place during the first stages. This greatly aids in accounting for the well-known fact that the development toward a closed association proceeds with such increasing rapidity when once a few plants gain a foothold. Attention has been frequently called to the importance of pioneers as shade-producers, while their effectiveness in reducing transpiration has been underestimated.

On the Hawaiian beaches a combination of factors—warmth, brilliant insolation, and exposure to powerful and rarely intermittent winds—tend to augment transpiration, and make of it an influence of great potency in retarding certain plants and completely inhibiting many others.

HAWAIIAN TIDES AS RELATED TO THE LITTORAL

On all oceanic coasts and embayments the tides exert an influence of greater or less power in determining the seaward limits of the land vegetation, and the landward extensions of the marine flora. In regions where the tidal range is great the effect upon the shore-line vegetation is proportionately augmented; in regions where the range is slight, its influence is small or negligible. The Hawaiian Archipelago comes under the latter class.

The greatest tidal contrasts in the Hawaiian Islands are due to coastal topography, i. e., sea-cliffs contrasted with mud-flats that lie only a few inches above low tide. At the foot of the sea-cliffs which rise directly from the water is a tidal (and wave-splash) zone of two or three feet. This zone is conspicuously marked by the coralline algae, which form a reddish-purple or lavender band. If conditions for land-plants are favorable, they may occur only a few feet above this zone, within reach of the salt spray, and from a distance appear to rise from the sea itself. Plant-clad cliffs of this character also occur in many of the South Pacific islands.

The mud-flats, however, present broad, rocky, mud-covered platforms, a few rods to a half-mile in width, almost free from seawater at low tide, but covered at high tide with six to twenty-four inches of water. The land vegetation is restricted to the shoreward limits of these flats. The absence of the land-building halophytes—*Rhizophora*, *Bruguiera*, *Ceriops*, *Kandelia*, etc.—makes invasion very slow.

The mean range of the Hawaiian tides is very slight, that at Honolulu being 1.3 feet, and that at Hilo, 1.8 ft. These ranges are typical for all the islands, and contrast forcibly with the large ranges of many other littorals. For example at Apia, Samoa, the average rise is 3 ft. per tide; the tides in Sydney Harbor rise 6–7 ft.; Johnson and York ('15, p. 131) in their comprehensive ecological study of the tide-levels at Cold Spring Harbor, New York, found a mean tidal range of 7.63 ft., with a variation of from 4.2 ft. to 10.8 ft.

The following data from the U. S. Coast and Geodetic Survey Tide Tables show the tidal range through a single typical month, January, at Honolulu, in feet:

Date	Moon	1	2	3	4
3	New; farthest south.....	2.2	0.1	0.6	−0.2
4	Perigee.....	2.3	0.1	0.6	−0.1
9	Equator.....	0.5	1.4	0.0	1.0
10	First quarter.....	0.7	1.2	0.0	1.2
16	Farthest south	2.1	0.2	0.6	−0.1
18	Full moon; apogee.....	2.1	0.2	0.6	−0.1
24	Equator	0.4	1.3	0.0	1.1
26	Third quarter	0.7	0.9	0.0	1.5
30	Farthest south	2.1	0.2	0.7	−0.2

Contrasting sharply with the poorly defined tidal zones of the Hawaiian littoral are those regions with large tidal fluctuations. For example, Ganong ('06, p. 85) in his studies of the Miscou Island littoral, in the extreme northeast corner of New Brunswick, on the Gulf of St. Lawrence, found three well defined beach zones:

First—"a broad sloping inter-tidal beach of pure sand without vegetation." This corresponds to the mud-flats along the southern shores of Oahu.

Second—a "narrow band between ordinary and extreme high tides." This zone was practically barren of vegetation. This zone is negligible in Hawaii.

Third—a "broad shelf, . . . reached only by the very highest tides." This is an "upper beach," and is characterized by scattered drift-wood and dry, ever-shifting sand. Some of the typical plants of this zone are *Salsola Kali*, *Cakile edulenta*, *Atriplex patula hastata*, and *Ammophila arenaria*. Ganong states "that

this vegetation is distinctly adjusted to the physical conditions, for it is of great paucity, of small and slow growth, annually renewed, closely ground-appressed, and strongly xerophytic."

Brownlie ('02) makes much of the irregularity of the tidal intervals in the Pacific, and states that at Honolulu the intervals of time from one high water to the next vary from ten and three-quarters to thirteen and three-quarters hours. A range so wide apart shows great irregularity compared with the absolute regularity of the movements of the moon. Although this tidal phenomenon is of great significance from the standpoint of tide studies themselves, it is not a factor of any special importance in the littoral ecology of land-plants.

Although the Hawaiian marine flora is closely limited by tidal intervals, these intervals are of little significance in determining the zonation of land-plants, as compared with the importance of other ecological factors. This contrasts with the findings of Johnson and York ('15, p. 149), at Cold Spring Harbor, who state:

> A careful study of the vertical distribution of the littoral plants about this harbor shows that this depends primarily and very definitely on the relative time of their submergence and emergence with the rise and fall of the tide. Moreover, the vertical range of littoral species is strictly, sometimes very narrowly limited. There are no species here, except two or three algae, that are distributed "between tidemarks" (*i. e.*, from low water up to high water), as is so often reported. The nearest approach to this range found for any seed plant is that of *Spartina glabra*.

It must be noted that the above statement uses the term littoral in a relatively narrow sense, as does their further statement that the vertical range of a littoral plant is exactly proportional to the range of the tide. This does not apply to the customary usage of the term littoral, which includes all vegetation along the coasts or strands, the ranges of which are more or less closely maritime.

NATURE OF THE SUBSTRATUM

The character of the littoral substratum obviously plays an important rôle in determining the nature and distribution of the littoral flora. Warming ('09, p. 223) groups halophytic plants into four classes, according to the nature of the substratum upon which they reach their optimum development: lithophilous, psammophilous, pelophilous, and helophilous. This will serve as a convenient basis for classifying the Hawaiian strand, with the

reservation that not all strand plants are halophytes. The Hawaiian types to be considered may he referred to the lithophilous and psammophilous classes, as follows:

A. Lithophilous

1. Sheet or flow lava.
2. Vertical rock shores or sea cliffs.
3. Littoral creviced rocks.
4. Lava boulder and pebble beaches.
5. Tufa beaches.
6. Coral limestone strands.

B. Psammophilous

7. Coral sand.
8. Root molds.

1. *Sheet or flow lava.*—This type of strand is of first importance in the Hawaiian group, both quantitatively and from the standpoint of ecologic history. There are more miles of lava beach than of any other type, or of all the other types combined. The relatively large areas and recent formation of Maui and Hawaii have caused this to be the dominant type. Historically it is first to appear, and it eventually gives way to strands of other types. The lava flows may be either relatively recent and uneroded, like many on the island of Hawaii, or they may be of extreme antiquity and deeply carved, like those of the Na Pali coast of Kauai, or Kaena and Makapuu, on Oahu. The beach itself, in either case, is formed of exposed lava beds, very rocky, with practically no sand or soil, and distinctly uncongenial to plant life. Lava sheet beaches occur on all the larger islands, but are best exhibited on the shores of Hawaii and East Maui. Every gradation may be found from very low, flat lava strands, only a few feet above sea-level, to bare sea precipices 600–700 feet in height.

From the historic standpoint the lava beach is of twofold significance. If of recent flow material—e. g., the Hawaii flows of 1840, '59, '68, '87—it indicates the extinction of the vegetation which occupied the old strand, and the exposure of a new littoral surface to plant invasion. On the other hand, in the early geo-

logical history of the islands the Hawaiian strand was wholly of sheet lava, and today remnants of this primitive beach condition exist here and there along the coasts. Thus there is great diversity in the ages of the various shores, and in the amount of plant invasion, both from within and from without, to which they have been exposed.

2. *Vertical rock shores or sea cliffs.*—These are composed either of sheet lava or laminated tufa. They are produced by sea action and fracture. Some of the stupendous sea-cliffs of Hawaii, Molokai, and Kauai, may have been produced by volcanic or seismic activity. The sea-cliffs either rise sheer from the water, or have a narrow strand at the base; this depends upon the depth of the off-shore water and both conditions are of frequent occurrence. None of the sea-cliffs, no matter how precipitious or apparently uncongenial for plant life, are wholly devoid of vegetation. Here and there on the surface of the cliff are crevices, ledges, and little pockets where plants establish themselves.

On the arid precipices—e. g., Koko Head, Makapuu, Mokapu and Kaena—occur such plants as *Euphorbia cordata*, *Lepidium owaihense*, *Schiedea globosa*, *Kadua littoralis*, *Tetramolopium* spp., *Lipochaeta integrifolia*, *Gossypium tomentosum*, *Sida* spp., *Jacquemontia sandwicensis*, *Boerhaavia diffusa*, *Cassia Gaudichaudii* and *Capparis sandwichiana*.

On the humid sea-cliffs—e. g., Waipio, Nahiku and East Molokai—are such forms as *Campylotheca molokaiensis*, *Schiedea Lydgatei*, *Lysimachia spathulata*, *Metrosideros polymorpha*, *Tribulus cistoides* and *Nama sandwicensis*.

3. *Littoral creviced rocks.*—Along the lava flow and tufa-cliff coasts, and to a lesser degree along the uplifted coral limestone shores, the rock crevices are the special habitats of many strand plants. The crevices are of two kinds: those due to the lamination of the rock, that is of the sheets or layers of lava or tufa; and those due to the vertical faulting of these layers. The former condition produces horizontal crevices, which on the sea-cliffs often front on ledges of greater or less magnitude. The vertical checking and faulting produces numberless irregular crevices upon the surface of the exposed strata, and in these crannies soil, seeds, and spores are lodged. Many of the crevices are less than an inch in

width, and the plants grow on top of the crevice, merely rooting in it. Others are several inches wide, and the smaller plants, such as *Lipochaeta succulenta*, *Lepidium owaihense*, and *Cressa cretica*, grow down within the crevice, only the upper parts of the branches showing above the rock. In the very large fissures,—one to three feet wide, the entire plant body may be concealed within the fissure.

4. *Lava boulder and pebble beaches.*—Wherever the shore line lava-sheets are subjected to the action of the sea, they are gradually broken into massive boulders, which in turn are slowly ground into pebbles. These metamorphoses are abundantly illustrated along the windward coasts of Hawaii, Maui, and Molokai, and in such places as Kaena, Oahu, and Kilauea, Kauai.

The boulders are usually 2–3 ft. in diameter, more or less oblate, smooth, black, very hard, heavy, and resonant. A beach composed of these ponderous rocks is very impressive, particularly during storm time, when the sea mills them with irresistible power. In various places, especially on the coasts of Kauai and Oahu, the lava boulders are consolidated in a calcareous matrix, formed of re-deposited coral lime.

The seaward portion of a boulder beach is barren of terrestrial vegetation, as is to be expected, but the upper or landward portion, which is not disturbed by ordinary wave action, is the habitat of such forms as *Sesuvium Portulacastrum*, *Ipomaea glaberrima*, *I. insularis*, *Euphorbia cordata*, *Tetramolopium* sp., *Kadua littoralis*, and *Wikstroemia Uva-ursi*.

The pebble beaches are relatively uncommon on Kauai and Oahu, but are more common on Maui and Hawaii. The pebbles, at the upper margin of the beach, are intermingled with soil, and the line of demarcation between beach and lowland is not distinct.

5. *Tufa beaches.*—Tufa craters occur here and there throughout the islands, from sea-level up to the highest mountain summits. In a few instances tufa cones stand so close to the shore line that the sea has cut beach platforms in their slopes. In these cases the strand is made of the solid wave-cut tufa rock. Leahi, Koko Head, Koko Crater, Manana, and Mokapu, illustrate this condition. The tufa is soft and easily sculptured by the waves; it usually does not form boulders or pebbles, but fractures easily and

disintegrates into mud. The main part of the tufa platform is wave-swept and barren of vegetation; the upper portion is the habitat of such forms as *Nama sandwicense*, *Sicyos hispidus*, *Jacquemontia sandwicensis*, *Tribulus cistoides*, *Cenchrus calyculatus*, *Waltheria americana*.

Tufaceous sand or mud is brownish or yellowish green in color, much finer in texture than the coral sand, and much more retentive of moisture. It often contains large quantities of olivine; this imparts the greenish hue. Some common plants of the muddy beaches are: *Batis maritima*, *Polypogon littoralis*, *Thespesia populnea*, *Ruppia maritima*, *Cyperus laevigatus*, *Chenopodium album*.

A number of small islets, such as Moku Manu, Manana and Molokini, are made up largely or wholly of tufaceous deposits, and represent the eroded remains of former tufa cones.

6. *Coral limestone strands.*—Within recent geological times there has been a slight uplift at various points in the Archipelago, which has resulted in elevating above sea-level broad shelves of coral limestone. Such areas are especially abundant on the island of Oahu, and portions of the shore around Pearl Harbor, Kaneohe Bay, Waianae, Kahuku, and Barber's Point are formed of the exposed coral limestone. These shores are often undercut by the surf, and are sculptured from above by the action of rain-water. The limestone along the beach may be actually wave-washed, or may be more or less buried beneath coral sand. Further back from the shore it is usually covered with a layer of soil.

7. *Coral sand.*—Beaches of pure coral sand are abundant on the islands of Oahu and Kauai, and also occur on the islands of Maui and Molokai. On the coral atolls to the leeward the coral strand is, of course, dominant. The sand is washed ashore from the coral reefs, and sometimes accumulates in sufficient quantities to form dunes. Mana, Kauai, Makaha and Heleloa, Oahu, and West Molokai, are representative dune regions. Fine stretches of coral beach may be found at Waikiki, Makapuu, Waimanalo, Mokapu, Kanuku, Waianae, and Ewa.

The Hawaiian coral strands correspond to the xerophytic beaches of Cowles ('99, p. 112), who recognizes two classes of beaches: hydrophytic and xerophytic, defining the latter as essen-

tially a product of wave action and comprising the zone which is or has been worked over by the waves. Hence the beach may be defined as the zone between the water level and the topographic form produced by other agents. This definition is closely applicable to the Hawaiian coral sand beaches, which are uniformly xerophytic in their characteristics. Olsson-Seffer ('10) has stated that the competition for food is more intense, the water supply less, the light stronger, the temperature higher, the transpiration greater, the foothold more uncertain and difficult, the conditions for plant life generally more adverse, than on any other soil.

Shaler ('94) has made some significant generalizations concerning sandy beaches. He points out that dunes and beaches of coral sand never march far inland, as do quartz sand dunes, for the reason that the limestone grains speedily become consolidated into a tolerably firm set rock. It is characteristic of coral beaches that the materials of which they are composed, unlike those of ordinary shores, are readily taken into solution, and in that state may be borne away by the currents to any distance. Notwithstanding the constant robbery of their materials, which is effected by the solving process, the coral beaches often widen with great rapidity. Shaler emphasizes that one of the most noticeable features which is exhibited by beach sands is their extraordinary endurance of the beating of the waves. He compares the rapid abrasion of rocks and boulders to the very insignificant abrasion of sand particles. Though subjected for ages to the beating of the waves, with perhaps a hundred times as much energy applied to the surface of which it forms a part as would suffice to reduce a granite boulder containing a cubic foot of material to a granular or powdery state, the beach sand remains unworn. This endurance is due to the capillary water. So long as the beach is full of water the particles do not touch each other. Thus the blow of the waves is used up in compressing the interstitial water and is converted into heat without wearing the mineral matter in an appreciable degree.

Sandy beaches have a relatively slight water capacity, as the percolation is very rapid. The capillarity is not as pronounced as in soils of finer texture, and the evaporation from a sandy surface

is quite rapid. All of these conditions tend to greatly reduce the available water supply of a beach, even though the latter be exposed to normal precipitation. In other words, the physical characteristics of the sandy beach, as has already been suggested, tend strongly toward xerophytism. Olsson-Seffer ('10) shows that it is the volume of water which a soil is capable of placing at the disposal of the plant, which is the limiting factor in the production of its vegetative covering and the controlling condition in the distribution of this vegetation. Percolation in sand is so rapid that were it not for the counteracting influence of surface tension very little water would be retained by sand. Permeability increases as the sand particles increase in size. Internal dew formation in the sand is the direct cause of a portion of the permanent moisture of the strand or dune. It is also to be noted, in this connection, that extreme changes in the salinity of the soil water, due to flooding by fresh water, are detrimental to the strand flora.

The two important constituents of the soil water of the sandy beach are lime and salt. On coral beaches the percentage of lime is very high. It is dissolved out by the rain-water, and ultimately forms consolidated limestone. The soluble salt content is coastal and is not of as great ecologic importance as was formerly supposed. An excellent statement is given by Olsson-Seffer ('10). Sandy soil yields its water to plants more freely than do other soils, and below the superficial layer of dry sand there is always a surprising amount of water. Fuller ('12) found this to be more than double the wilting coefficient of dune soil.

Owing to the frequent inundations by waves and subsequent rapid changes in evaporation, the soil temperatures of the lower sand beach are more variable than on any other formations of the sandy strand. On account of the low specific heat of sand, the surface layers are rapidly heated in the daytime and quickly cooled at night. Thus there is considerable fluctuation of diurnal temperatures.

The list of plants enumerated by Schauinsland ('99) as occuring on the Laysan atoll may be taken as representative of the coral strand flora of the leeward isles. This list includes:

Lepidium owaihense
*Capparis sandwichiana**
Portulaca oleracea
Tribulus cistoides
Sicyos hispidus
Sicyos microcarpus
Sesuvium Portulacastrum
Lipochaeta integrifolia
Scaevola Lobelia
Solanum laysanense
Ipomoea Pes-caprae
Ipomoea insularis
Nama sandwicensis
Heliotropium curassavicum
Phyllostegia variabilis
Boerhaavia diffusa
Achyranthus splendens
Euxolus viridis
Chenopodium sandwicheum
Santalum Freycinetianum
Cyperus laevigatus
Cyperus pennatus
Cenchrus calyculatus
Sporobolus virginicus
Eragrostis hawaiiensis
Lepturus repens
Pritchardia Gaudichaudii

8. *Root-Molds.*—An interesting formation along the Hawaiian littoral, that has also been recorded from other parts of the world (see Dolley, '89, pp. 131, 132; and Darwin, '60), is the root-mold. This is well developed on sandy shores with persistent winds, where there has been considerable vegetation. The west end of Molokai, the Maui isthmus, Makapuu and Kaena on Oahu, and the Mana region of Kauai all possess notable root-mold formations. The molds are produced by the cementing together of the sand particles which lie near the ramifying roots of beach plants; the cementing process is undoubtedly due to specific root excretions, as well as to the percolating rain-water which follows the courses of the larger roots. In the course of time the vegetation dies, the winds sweep away the loose sand from around the more solid molds, and the latter are eventually exposed. They appear either as isolated cylinders, rising here and there above the sand, or as irregular masses of branching tubes. They rise to a height of three to twenty inches above the present level of the sand, and in color are white or yellowish brown.

The lumen varies from a fraction of an inch to nearly a foot and is rarely open; it is more or less completely filled with limestone. The smaller sizes are the most common, as the majority

* This abundant indigenous pseudolittoral was inadvertently omitted from the list on p. 276. It is a straggling shrub, inhabiting arid rocky lowlands and beaches; a favorite habitat, for example, is a rocky talus slope near the sea.

of beach plants are slender-rooted. Upon close examination the wall is found to be composed of sand, coral particles, and other minutiae compactly cemented together. In cross section the wall shows a very much hardened inner layer forming a distinct zone. The outer layer is relatively soft and easily crumbled.

These molds are the fossils of the root-ramifications of a previous plant formation. Molds identical in mode of formation with those of the coral strands are also plentiful in the tufa slopes, and attain much larger sizes than the sand molds. Punchbowl, Round Top, Diamond Head, and Koko Head are typical regions where these molds occur in abundance and in all stages of development.

COLLEGE OF HAWAII, HONOLULU

LITERATURE CITED

Aston, B. C. The raised beaches of Cape Turakirae. Trans. & Proc. New Zealand Inst. **44**: 208–213. *pl. 13, 14.* 1911.

Bishop, E. The cold-current system of the Pacific. Science II. **20**: 338–340. 1904.

Brownlie, A. The tides in the midst of the Pacific Ocean. Bull. Geogr. Soc. **34**: 17–25, 117–131. *f. 1–3.* 1902.

Bryan, W. A. Deep subsidence of the Waianae Mountains. Thrum's Hawaiian Annual, **1916**: 95–125. *pl. 1, 2.* Honolulu. 1916.

Cockayne, L. A report on the sand dunes of New Zealand. Published by the Department of Lands, Wellington, New Zealand. 1911.

Cowles, H. C. The ecological relations of the vegetation of the sand dunes of Lake Michigan. Bot. Gaz. **27**: 95–117, 169–202, 281–308, 361–391. *f. 1–26.* 1899.

Dall, W. H. North Pacific currents. Science II, **20**: 436. 1904.

Darwin, C. Journal of researches into the natural history and geology of the countries visited during the voyage of H.M.S. *Beagle* round the world. London. 1860.

Dolley, S. The botany of the Bahamas. Proc. Nat. Sci. Philadelphia **1889**: 131–134. 1889.

Ernst, A. The new flora of the volcanic island of Krakatau. English translation. Cambridge. 1908.

Fuller, G. D. Evaporation and plant succession. Bot. Gaz. **52**: 193–208. *f. 1–6.* 1911.

Ganong, W. F. The nascent forest of the Miscou beach plain. Bot. Gaz. **42**: 81–106. *f. 1–14.* 1906.

Guppy, H. B. Observations of a naturalist in the Pacific between 1896 and 1899. **2**. London. 1906.

Hedley, C. Ecological sketch of the Sydney beaches. Jour. and Proc. Roy. Soc. New South Wales **49**: 15–77. *pl. 1–7*. 1915.

Hemsley, W. B. Report on the Botany of Juan Fernandez, the south-eastern Moluccas, and the Admiralty Islands. Challenger Rep. Botany **1**[3]. 1884.

————. Report on present state of knowledge of various insular floras. Challenger Rep. Botany **1**[1]. 1885.

Hooker, J. D. On the vegetation of the Galapagos Archipelago, as compared with that of some other tropical islands and of the continent of America. Trans. Linn. Soc. **20**: 235–262. 1847.

Jost, L. Lectures on plant physiology. English translation. Oxford. 1907.

Johnson, D. S., & York, H. H. The relation of plants to tide-levels. Carnegie Inst. Wash. Publ. 206: 1–162. *pl. 1–24* + *f. 1–5*. 1915.

Olsson-Seffer, P. H. Relation of soil and vegetation on sandy seashores. Bot. Gaz. **47**: 85–126. *f. 1–12*. 1909.

————. Genesis and development of sand formations on marine coasts. Augustana Libr. Publ. **7**: 6–183. *f. 1–16*. 1910.

Pfeffer, W. The physiology of plants. 2d ed. English translation. **2**. Oxford. 1903.

Schauinsland, H. H. Drei Monate auf einer Koralleninsel. Bremen. 1899.

Schimper, A. F. W. Plant geography upon a physiological basis. English translation. Oxford. 1903.

————. Die indo-malayische Strandflora. Bot. Mitt. aus den Tropen **3**. Jena. 1891.

Shull, G. H. The longevity of submerged seeds. Plant World **17**: 329–337. *f. 1, 2*. 1914.

Shaler, N. S. Phenomena of beach and dune sands. Bull. Geogr. Soc. Amer. **5**: 207–13. 1894.

Tansley, A. G., & Fritsch, F. E. Flora of the Ceylon littoral. New Phytol. **4**: 1–17. 1905.

Transeau, E. N. The relation of plant societies to evaporation. Bot. Gaz. **45**: 217–231. *f. 1–19*. 1908.

Warming, E. Oecology of plants. English edition. Oxford. 1909.

Wood-Jones, F. Coral and atolls. A history and description of the Keeling-Cocos Islands, with an account of their fauna and flora. London. 1912.

INDEX TO AMERICAN BOTANICAL LITERATURE

1913–1918

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

This Index is reprinted monthly on cards, and furnished in this form to subscribers at the rate of one cent for each card. Selections of cards are not permitted; each subscriber must take all cards published during the term of his subscription. Correspondence relating to the card issue should be addressed to the Treasurer of the Torrey Botanical Club.

Adams, J. F. *Keithia* on *Chamaecyparis thyoides*. Torreya **18**: 157–160. *f. 1, 2.* 7 S 1918.

Keithia Chamaecyparissi sp. nov. is described.

Anderson, P. J. Rose canker and its control. Massachusetts Agr. Exp. Sta. Bull. 183: 11–46. *pl. 1–3+f. 1–11.* My 1918.

Andrews, A. L. A collection of mosses from North Carolina. Bryologist **21**: 61–67. Jl 1918.

Arny, A. C., & Garber, R. J. Variation and correlation in wheat, with special reference to weight of seed planted. Jour. Agr. Research **14**: 359–392. *f. 1–8.* 26 Au 1918.

Artschwager, E. F. Anatomy of the potato plant, with special reference to the ontogeny of the vascular system. Jour. Agr. Research **14**: 221–252. *pl. 27–47.* 5 Au 1918.

Atkinson, G. F. Preliminary notes on some new species of agarics. Proc. Am. Philos. Soc. **52**: 354–356. 8 Au 1918.

New species are described in *Amanita* (2), *Hypholoma* (2), *Lactarius* (2), *Lepiota* (1) and *Pholiota* (1).

Bakke, A. L. Determination of wilting. Bot. Gaz. **66**: 81–116. *f. 1–5.* 15 Au 1918.

Bicknell, E. P. The ferns and flowering plants of Nantucket—XVIII. Bull. Torrey Club **44**: 369–387. 10 Au 1917;—XIX. Bull. Torrey Club **45**: 365–383. 20 S 1918.
Includes *Quercus rufescens* sp. nov.

Bisby, G. R., & Tolaas, A. G. Copper sulphate a disinfectant for potatoes. Phytopathology **8**: 240, 241. 11 My 1918.

Blakeslee, A. F. Unlike reaction of different individuals to fragrance in *Verbena* flowers. Science II. **48**: 298, 299. 20 S 1918.

Boas, H. M. The relationship between the number of sporophylls and the numbers of stamens and pistils—a criticism. Bull. Torrey Club **45**: 343–345. 9 S 1918.

Boyce, J. S. Imbedding and staining of diseased wood. Phytopathology **8**: 432–436. Au 1918.

Brenckle, J. F. North Dakota fungi—II. Mycologia **8**: 199–221. Jl 1918.
Hendersonia Crataegi sp. nov. is described and 9 new species in various genera are listed.

Britton, E. G. *Jagerinopsis squarrosa*, n. sp. Bryologist **21**: 48–50. *pl. 24.* 30 Jl 1918.

Britton, N. L. The botany and plant products of northern South America. Jour. N. Y. Bot. Gard. **19**: 182–185. Au 1918.
Published also in Science II. **48**: 156. 1918.

Brown, J. G. Abnormal conjugation in *Spirogyra*. Bot. Gaz. **66**. 269–271. *f. 1–3.* 16 S 1918.

Buchanan, R. E. Studies in the classification and nomenclature of the bacteria—VII. The sub-groups and genera of the Chlamydobacteriales. Jour. Bact. **3**: 301–306. My 1918.

Buchholz, J. T. Suspensor and early embryo of *Pinus*. Bot. Gaz. **66**: 185–228. *pl. 6–10+f. 1–3.* 16 S 1918.

Campbell, D. H. Studies on some East Indian Hepaticae. Ann. Bot. **32**: 319–338. *pl. 8, 9+f. 1–10.* Jl 1918.
Dumortiera calcicola sp. nov. is described.

Clute, W. N. The barberry and the wheat rust. Am. Bot. **24**: 85–87. Au 1918.

Clute, W. N. Flowers of varying colors. Am. Bot. **24**: 103–105. Au 1918.

[Clute, W. N.] Note and comment. Am. Bot. **24**: 106–113. Au 1918.
Includes notes on *Sedum ternatum* in Illinois, Spring flowers in autumn, Wilting of cut flowers, *Kochia alata*, Odor of *Amelanchier*, etc.

[Clute, W. N.] Two forms of leaves on the same plant. Am. Bot. **24**. 101, 102. Au 1918. [Illust.]

Collins, F. S. Notes from the Woods Hole Laboratory—1917. Rhodora **20**: 141–145. *pl. 124.* 1 Au 1918.

Includes *Microchaete naushonensis, Bulbochaete Furberae,* and *Erythrotrichia rhizoidea,* spp. nov.

Coutant, M. W. Wound periderm in certain cacti. Bull. Torrey Club **45**: 353–364. *pl. 9+f. 1–3.* 20 S 1918.

Cunningham, B. Cross-conjugation in *Spirogyra Weberi.* Bot. Gaz. **66**: 272, 273. *f. 1.* 16 S 1918.

Davidson, A. Additions to the local flora. Bull. So. Calif. Acad. Sci. **17**: 60, 61. Jl 1918.

Davidson, A. *Lupinus mollisifolius* spec. nov. Bull. So. Calif. Acad. Sci. **17**: 57. Jl 1918.

Davidson, A. *Lupinus Paynei* spec. nov. Bull. So. Calif. Acad. Sci. **17**: 58, 59. Jl 1918. [Illust.]

Detwiler, S. B. Battling the pine blister rust. Am. Forestry **24**: 451–457. Au 1918. [Illust.]

Dodge, B. O. Studies in the genus *Gymnosporangium*—III. The origin of the teleutospore. Mycologia **8**: 182–193. *pl. 9–11.* Jl 1918.

Drechsler, C. The taxonomic position of the genus *Actinomyces.* Proc. Nat. Acad. Sci. **4**: 221–224. Au 1918.

East, E. M. The home of the sovereign weed. Sci. Mo. **7**: 170–178. Au 1918.

Emig, W. H. *Octodiceras Julianum* Brid. var. *ohioense,* new variety. Bryologist **21**: 60, 61. *pl. 26.* Jl 1918.

Farr, C. H. Cell division by furrowing in *Magnolia.* Am. Jour. Bot. **5**: 379–395. *pl. 30–32.* 3 Au 1918.

Felt, E. P. Gall insects and their relations to plants. Sci. Mo. **6**: 509–525. Je 1918. [Illust.]

Foxworthy, F. W. Philippine Dipterocarpaceae, II. Philip. Jour. Sci. **13**: (Bot.) 163–199. *pl. 1, 2.* My 1918.

Seventeen new species are described.

Fred, E. B., & Davenport, A. Influence of reaction on nitrogen-assimilating bacteria. Jour. Agr. Research **14**: 317–336. 19 Au 1918.

Frye, T. C. The age of *Pterygophora californica.* Publ. Puget Sound Biol. Sta. **2**: 65–71. *pl. 17.* 1 Jl 1918.

Frye, T. C. Illustrated key to the western Sphagnaceae. Bryologist **21**: 37–48. *pl. 17–23.* 30 Jl 1918.

Goodspeed, T. H. Modified safety-razor blade holder for temperature control. Bot. Gaz. **66**: 176, 177. *f. 1.* 15 Au 1918.

Graham, M. Centrosomes in fertilization stages of *Preissia quadrata* (Scop.) Nees. Ann. Bot. **32**: 415–420. *pl. 10.* Jl 1918.

Harper, R. M. A new seasonal precipitation factor of interest to geographers and agriculturists. Science II. **48**: 208–211. 30 Au 1918.

Harris, J. A. Secondary parasitism in *Phoradendron*. Bot. Gaz. **66**: 275–276. 16 S 1918.

Harshberger, J. W. Ecological society of America. The preservation of our native plants. Torreya **18**: 162–165. 7 S 1918.

Hasselbring, H. Effect of different oxygen pressures on the carbohydrate metabolism of the sweet potato. Jour. Agr. Research **14**: 273–284. 12 Au 1918.

Henderson, M. P. The black-leg disease of cabbage caused by *Phoma lingam* (Tode) Desmaz. Phytopathology **8**: 379–431. *f. 1–10.* Au 1918.

Hibbard, R. P. Physiological balance in the soil solution. Michigan Agr. Exp. Sta. Tech. Bull. 40: 1–44. *f. 1–8.* S 1917.

Holm, T. Joan Baptista Porta. Am. Nat. **52**: 455–461. S 1918.

Hotson, J. W. *Sphagnum* as a surgical dressing. Science II. **48**: 203–208. 30 Au 1918.

Johnston, I. M. A few notes on the botany of southern California. Bull. So. Calif. Acad. Sci. **17**: 64–66. Jl 1918.

Johnston, I. M. Some undescribed plants from southern California. Bull. So. Calif. Acad. Sci. **17**: 63, 64. Jl 1918.
Lupinus elatus sp. nov. is described.

Jones, D. F. The effect of imbreeding and crossbreeding upon development. Proc. Nat. Acad. Sci. **4**: 246–250. *f. 1, 2.* Au 1918.

Keeler, H. L. The wayside flowers of summer. i–xiii+1–288. New York. 1917. [Illust.]

Koessler, J. H. Studies on pollen and pollen disease.—I. The chemical composition of ragweed pollen. Jour. Biol. Chem. **35**: 415–424. S 1918.

Lipman, C. B., & Waynick, D. D. A bacteriological survey of the soil of Loggerhead Key, Tortugas, Florida. Proc. Nat. Acad. Sci. **4**: 232–234. Au 1918.

Livingston, B. E., & Tottingham, W. E. A new three-salt nutrient solution for plant cultures. Am. Jour. Bot. **5**: 337–346. 3 Au 1918.

Lorenz, A. Notes on *Radula obconica* Sull. Bryologist **21**: 56–59. *pl. 25.* Jl 1918.

Love, H. H., & Craig, W. T. The relation between color and other characters in certain *Avena* crosses. Am. Nat. **52**: 369–383. S 1918.

MacCaughey, V. An endemic *Begonia* of Hawaii. Bot. Gaz. **66**: 273–275. 16 S 1918.

MacCaughey, V. The olona, Hawaii's unexcelled fibre plant. Science II. **48**: 236–238. 6 S 1918.

MacCaughey, V. A survey of the Hawaiian coral reefs. Am. Nat. **52**: 409–438. *f. 1–9.* S 1918.

MacDaniels, L. H. The histology of the phloem in certain woody angiosperms. Am. Jour. Bot. **5**: 347–378. *pl. 24–29.* 3 Au 1918.

Matz, J. Some diseases of the fig. Florida Agr. Exp. Sta. Bull. **149**: 1–10. *f. 1–5.* Au 1918.

McCubbin, W. A. Peach canker. Canada Dept. Agr. Dom. Exp. Farms Bull. 37: 1–20. *pl. 1–6+f. 1, 2.* 1918.

McCulloch, L. A morphological and cultural note on the organism causing Stewart's disease of sweet corn. Phytopathology **8**: 440, 441. *pl. 1.* Au 1918.

Merrill, E. D. Notes on the flora of Loh Fau Mountain, Kwangtung Province, China. Philip. Jour. Sci. **13**: (Bot.) 123–161. My 1918.
Twenty-three new species are described.

Moxley, G. L. Additions to the lichen flora of southern California. Bull. So. Calif. Acad. Sci. **17**: 61, 62. Jl 1918.

Murrill, W. A. Illustrations of fungi—XXIX. Mycologia **10**: 177–181. *pl. 8.* Jl 1918.
Prunulus viscidipes sp. nov., *Laccaria amethystea, L. striatula, Leptoniella conica* sp. nov., *Prunulus galericulatus, Omphalopsis fibula, Clitocybe farinacea, Marasmius dichrons* and *M. institius* are illustrated in color.

Nash, G. V. Hardy woody plants in the New York Botanical Garden. Jour. N. Y. Bot. Gard. **19**: 58–62. Mr 1918; 86–91. Ap 1918; 108–112. My 1918; 139–142. Je 1918; 167–171. Jl 1918; 192–196. Au 1918.

Nelson, J. C. An addition to our food plants. Am. Bot. **24**: 97–99. Au 1918.
Crambe maritima.

Nelson, J. C. A new form of *Prunella vulgaris.* Am. Bot. **24**: 82–85. Au 1918. [Illust.]

Nichols, G. E. War work for bryologists. Bryologist **21**: 53–56. Jl 1918.

Nothnagel, M. Fecundation and formation of the primary endosperm nucleus in certain Liliaceae. Bot. Gaz. **66**: 143–161. *pl. 3–5.* 15 Au 1918.

O'Gara, P. J. The white-spot disease of alfalfa. Science II. **48**: 299–301. 20 S 1918.

Paulsen, O. A new *Cereus* from the West Indies. Jour. Bot. **56**: 235. Au 1918.

Cereus venditus.

Peltier, G. L. Susceptibility and resistance to citrus-canker of the wild relatives, citrus fruits, and hybrids of the genus *Citrus*. Jour. Agr. Research **14**: 337–358. *pl. 50–53.* 26 Au 1918.

Peltier, G. L., & Neal, D. C. A convenient heating and sterilizing outfit for a field laboratory. Phytopathology **8**: 436–438. *f. 1, 2.* Au 1918.

Pennell, F. W. A plea for *Aureolaria*. Rhodora **20**: 133–137. 1 Au 1918.

Potter, R. S., & Snyder, R. S. The production of carbon dioxide by molds inoculated into sterile soil. Soil Sci. **5**: 359–375. *pl. 1+f. 1–4.* My 1918.

Reichert, E. T. The differentiation and specificity of starches in relation to genera, species, etc. Part I. i–xvii+1–342+[1–21]. *pl. 1–102.* Washington. 1913; Part II. i–xvii+343–900+[1–18]. Washington. 1913.

Carnegie Publ. No. 173.

Riddle, L. W. Some extensions of ranges. Bryologist **21**: 50. 30 Jl 1918.

Roberts, J. W. The source of apple bitter-rot infections. U. S. Dept. Agr. Bull. 684: 1–25. *pl. 1–5.* 19 Au 1918.

Robertson, C. Pollination of *Asclepias cryptoceras*. Bot. Gaz. **66**: 177. 15 Au 1918.

Sargent, C. S. Notes on North American trees.—II. *Carya*. Bot. Gaz. **66**: 229–258. 16 S 1918.

Includes *Carya leiodermis* sp. nov. and many new varieties and combinations.

Schneider, C. Notes on American willows—I. The species related to *Salix arctica* Pall. Bot. Gaz. **66**: 117–142. 15 Au 1918.

Schwarze, C. A. The parasitic fungi of New Jersey. New Jersey Agr. Exp. Sta. Bull. 313: 1–226. *f. 1–1056.* S 1917.

Shear, C. L., & Stevens, N. E. Plant pathology today. Sci. Mo. **7**: 235–243. S 1918.

Shear, C. L., Stevens, N. E., Wilcox, R. B., & Rudolph, B. A. Spoilage of cranberries after harvest. U. S. Dept. Agr. Bull. 714: 1–20. 9 Au 1918.

Shufeldt, R. W. Midsummer flower-hunts. Am. Forestry **24**: 489–496. *f. 1–10.* Au 1918.

Sinnott, E. W. Factors determining character and distribution of food reserve in woody plants. Bot. Gaz. **66**: 162–175. *f. 1, 2.* 15 Au 1918.

Skottsberg, C. The islands of Juan Fernandez. Geog. Rev. **5**: 362–383. *f. 1–20.* My 1918.

Soth, B. H. Blossoms by the wayside in the Rockies. Am. Bot. **24**: 88–91. Au 1918. [Illust.]

Spegazzini, A. Observaciones microbiológicas. An. Soc. Cien. Argentina **85**: 311–323. Je 1918.

Includes the new genera *Amphoropsis*, *Myriapodophila*, *Thaxteriola*, *Entomocosma*, and several new species in the Laboulbiniales, and two new species in *Chantransiopsis*.

Stevens, N. E. American botany and the great war. Science II. **48**: 177–179. 23 Au 1918.

Stevenson, J. A. Citrus diseases of Porto Rico. Jour. Dept. Agr. Porto Rico 2: 43–123. Ap 1918.

Stone, R. E. Incubation period of *Cronartium ribicola* on the white pine. Phytopathology **8**: 438–440. Au 1918.

Sudworth, G. B. Miscellaneous conifers of the Rocky Mountain region. U. S. Dept. Agr. Bull. 680: 1–45. *pl. 1–13+maps 1–9.* 14 Au 1918.

Thériot, I. Note sur une mousse du Chili, *Barbula flagellaris* Schp. Rec. Publ. Soc. Havraise d'Études Div. (1er Trimestre 1917), pp. 1–7. 1917.

Turner, C. E. Plant and animal life in the purification of a polluted stream. Sci. Mo. **7**: 34–45. Jl 1918. [Illust.]

Veitch, F. P., & Rogers, J. S. American sumac: a valuable tanning material and dyestuff. U. S. Dept. Agr. Bull. 706: 1–12. *pl. 1–5.* 26 Jl 1918.

Weatherwax, P. The evolution of maize. Bull. Torrey Club **45**: 309–342. *f. 1–36.* 9 S 1918.

Weir, J. R., & Hubert, E. E. Cultures with *Melampsorae* on *Populus*. Mycologia **8**: 194–198. Jl 1918.

Weniger, W. Fertilization in *Lilium*. Bot. Gaz. **66**: 259–268. *pl. 11–13*. 16 S 1918.

Wieland, G. R. The origin of dicotyls. Science II. **48**: 18–21. 5 J. 1918.

Williamson, E. B. A collecting trip to Colombia, South America. Univ. Michigan Mus. Zoo. Misc. Publ. 3: 1–24. 22 F 1918.

Wodehouse, R. P. Direct determination of permeability. Jour. Biol. Chem. **29**: 435–458. 1917.

Wolf, W. *Quercus bernardiensis* sp. nov. Torreya **18**: 161, 162. 7 S 1918.

Woodward, R. W. Some Connecticut plants. Rhodora **20**: 97, 98. 1 My 1918.

Woodward, R. W. Some Rhode Island grasses. Rhodora **20**: 116. 11 Je 1918.

Woodward, R. W. A *Salix rostrata* hybrid? Rhodora **20**: 132. 22 Jl 1918.

Young, H. C., & Cooper, E. H. A method for determining the fungicidal coefficient of lime sulphur and other common fungicides. Ann. Rep. Michigan Acad. Sci. **19**: 221–236. 1917.

Young, V. H. Some factors affecting inulase formation in *Aspergillus niger*. Plant World **21**: 75–87. Ap 1918.

Zeller, S. M. An interesting fungus from Friday Harbor, Washington. Publ. Puget Sound Biol. Sta. **2**: 95, 96. 1 Jl 1918.
Rhizopogon diplophloeus.

Zimmerman, H. E. A tree that owns itself. Am. Bot. **24**: 81, 82. Au 1918. [Illust.]

INDEX TO VOLUME 45

New names and the final members of new combinations are in **bold face type.**

Abies balsamea, 37
Abrus precatorius, 277
Acacia Cavenia, 270; farnesiana, 276, 489; koa, 275
Acer pennsylvanicum, 37, 42; rubrum, 37; saccharum, 31, 37, 42, 205; spicatum, 38
Achillea Millefolium, 39
Achryanthus aspera, 277; obovata, 148; splendens, 274, 500; splendens rotundata, 274
Actaea alba, 31, 39; rubra, 207, 379
Actinostroma infundibuliformis, 461
Adiantum pedatum, 31, 94
Adenostegia, 400; Bolanderi, 406; Bolanderi capitata, 403, 404; ciliosa, 404; canescens, 419, 421; filifolia, 403, 410; **Hanseni**, 400, 403, 408; **Helleri**, 417; laxiflorus, 401; **littoralis**, 403, 413; Kingii, 416; mollis, 419; maritima, 420; Nevinii, 403, 409; Orcuttiana, 418; **palmata**, 419; Parryi, 421; **parviflora**, 403, 409; pilosa, 403, 405; Pringlei, 402; ramosa, 403, 414; rigida, 403, 411; rigida brevibracteata, 403, 412; tenuis, 403, 406; viscida, 400, 403, 407; Wrightii, 403
Adenostegia, Taxonomy and distribution of, 399
Aecidium **anthericicola**, 149; Atriplicis, 141; **Cyrillae**, 150; **conspicuum**, 153; Hyptidis, 454; **Keerliae**, 154; **Mozinnae** 152; myricatum, 291; **Pereziae**, 153; **plenum**, 149; ranunculacearum, 147; Rosae, 454; roseum, 154; **steviicola**, 154; **Thenardiae**, 150; **Tithymali**, 151; tucumanense, 454
Aegopogon, 154
Aethusa Cynapium, 56
Agrostemma Githago, 379
Aira caryophyllea, 369
Air chambers of Grimaldia fragrans, The, 235
Aleurites moluccana, 271, 276
Alisma subcordatum, 368
Alnus incana, 37
Alopecurus geniculatus, 369
Alsine graminea, 379
Ambrosia artemisiifolia, 40
Amelanchier canadensis, 292, 295; intermedia, 292, 294; nantucketensis, 380; oblongifolia, 381; sp., 33, 38; stolonifera, 381
Ammophila arenaria, 492
Amsinckia arenaria, 382; intermedia, 382
Anacardium occidentale, 271
Andromeda glaucophylla, 38, 42
Anthericum nanum, 149
Antidesma platyphyllum, 134
Apocynum androsaemifolium, 40; cannabinum, 40
Aralia nudicaulis, 38, 207; racemosa, 40
Arctium minus, 40
Arctostaphylos Uva-ursi, 33, 38, 382
Argemone intermedia, 150; mexicana, 276
Argyreia tiliaefolia, 275, 487, 489
Arisaema pusillum, 373
Aronia nigra, 38
ARTHUR, J. C. New species of Uredineae—X, 141
Asclepias incarnata, 39; syriaca, 39
Asarum canadense, 207
Aspidium aculeatum, 98; angulare, 98; auriculatum, 98, 99, 100; caryotideum, 98; chrysolobum, 98–100; falcatum, 97; Filix-mas, 97; Filix-mas cristatum, 98; Filix-mas genuinum, 98; hirtipes, 100–102; marginale, 207; spinulosum intermedium, 207; Tsus-Simense, 98, 100; varium, 99
Asplenium Filix-foemina, 365; nidus, 94
Aster macrophyllus, 40
Athyrium angustatum, 366; angustatum elatius, 366; angustatum rubellum, 366; asplenoides, 366
Atriplex, 271; confertifolia, 141; Nuttallii, 142; patula hastata, 492
Auricularia ampla, 456; corrugata, 455; lobata, 455; mesenterica, 451, 455; ornata, 455; phosphorea, 457; rugosissima, 456; sambucina, 457; tremelloides, 455; violacea, 455
Auriculareae, 455
Avena sativa, 55
Avicennia tomentosa, 270, 271
AVERY, B. T., HARRIS, J. A. &. Correlation of morphological variations in the seedling of Phaseolus vulgaris, 109

Barringtonia excelsa, 270; speciosa, 270

Batis maritima, 275, 487, 497
BERRY, E. W. Notes on the fern genus Clathropteris, 279
Betula lutea, 37, 204, 207; papyrifera, 37; populifolia, 375; pumila, 34, 38
BICKNELL, E. P. The ferns and flowering plants of Nantucket—XIX, 365
Bihai borinquena, 145; latispatha, 145
Bjerkandera adusta, 463
Blephariglottis ciliaris, 374
BOAS, H. M. The relationship between the number of sporophylls and the number of stamens and pistils—a criticism, 343
Boerhaavia diffusa, 275, 489 495, 500
Boletus abietinus, 466; isabellinus, 463; roseus, 465
Borrichia, 271
Botrychium Lunaria, 203; onondagense, 203; virginianum, 40
Bromus hordeaceus, 371; secalinus, 371; tectorum, 371
BROWN, E. W. Regeneration in Phegopteris polypodioides, 391
Bryum contortum, 445; extinctorium, 433, 437, 438, 441; pulvinatum, 433

Caeoma destruens, 452; exitiosum, 455; miniatum, 455; Rosae miniatum, 455
Caesalpinia Bonducella, 270, 271, 272, 276
Cakile, 271; edulenta, 492
Calamagrostis canadensis, 29, 38
Calophyllum inophyllum, 271, 275, 489
Caltha palustris, 40
Calystegia Soldanella, 270
Campanula rotundifolia, 58, 59, 62, 66; uliginosa, 40
Canavalia, 270, 271
Cannabis sativa, 378
Carapa moluccensis, 271; obovata, 271
Campylotheca molokaiensis, 274, 495
Capparis sandwichiana, 495, 500
Cardiospermum, 271; Halicacabum, 277
Carex arctata, 31, 39; filiformis, 29, 39; hirta, 372, Howei, 372; imcomperta, 372; laxiflora, 31; leptalea, 372; muricata, 372; sandwicensis, 276; stricta, 372; virescens, 372
Carpinus caroliniana, 375
Carrier of the mosaic disease, A, 219
Cassia Gaudichaudii, 275, 495
Cassytha filiformis, 272, 276
Castalia odorata, 379
Casuarina equisetifolia, 276
Celastrus scandens, 38
Cenchrus, 271; calyculatus, 276, 497, 500
Centrosema, 271
Cerbera Odollam, 270
Chaetochloa imberbis, 369; imberbis perennis, 369; occidentalis, 369; versicolor, 369
Chamaecyparis thyoides, 291
Chamaedaphne calyculata, 38
Chamaenerion angustifolium, 38
Chenopodium album, 276, 497; sandwicheum, 275, 500;
Chiococca, 271
Chiogenes, 36; hispidula, 39
Chloris, 271
Chloropyron canescens, 421; maritima, 420; palustre, 420; Parryi, 421
Chrysanthemum Leucanthemum, 39
Cichorium Intybus, 70
Cicuta bulbifera, 382
Cibotium Chamissoi, 134; Menziesii, 134
Cintractia affinis, 453; Krugiana, 453; leucoderma, 453
Circaea alpina, 40
Cissampelos Pariera, 270
Cladium leptostachyum, 276; mariscoides, 40
Cladoderris Blumeri, 461; elegans, 461; Decandolleana, 461; infundibuliformis, 461
Clarkia pulchella, 56
Clathropteris meniscioides, 280; platyphylla, 279, 280–285
Clavaria flagelliformis, 462
Clavarieae, 462
Clematis Drummondii, 146
Clermontia parviflora, 134
Clerodendron inerme, 270, 271
Clintonia borealis, 39
Coccoloba, 271
Cocos nucifera, 270, 271, 275
COKER, D. Revision of the North American species of Encalypta, 433
Coleosporium miniatum, 455
Colubrina asiatica, 270, 272, 274
Coltricia benguetensis, 464
Comandra umbellata, 40
Comarum palustre, 39
Comptonia asplenifolia, 291; peregrina, 38
Conocarpus erecta, 271
Conringia orientalis, 380
Convolvulus spithamaeus, 40, 271
Coptis trifolia, 39, 207, 379
Cora gyrolophia, 461; pavonia, 462
Cordea subcordata, 270, 271, 275
Cordylanthus bicolor, 404; capitatus, 404; canescens, 421; filifolius, 410, 411; filifolius brevibracteatus, 412; Kingii, 416; laxiflorus, 401; mollis, 419; maritimus, 420; Nevinii, 409; Orcuttianus, 418; Parryi, 421; pilosus, 405, 406; Pringlei, 402; ramosus, 414; rigidus, 411; tenuis, 406
Coriolopsis atypus, 464; melleoflavus, 463
Coriolus abietinus, 466; perpusillus, 466; rubritinctus, 466

Cornus canadensis, 39, 207; stolonifera, 38
Correlation of morphological variations in the seedling of Phaseolus vulgaris, 109
Corticium caeruleum, 451, 457
COUTANT, M. W. Wound periderm in certain cacti, 353
Crataegus chrysocarpa, 381; oxyacantha, 287
Crepidula plana, 53
Cressa cretica, 275, 487, 496
Crotolaria sp., 277
Crotonopsis argentea, 478, 479; elliptica, 478; linearis, 477, 478, 479; spinosa, 478, 479
Cudonia, 79
Cyanea arborea, 135; **Giffardii**, 133, 134; noli-me-tangere, 136; **rollandioides**, 135; superba, 134; tritomantha, 136
Cycas circinalis, 271
Cyclomyces spadiceus, 467; tabacinus, 467
Cycloporellus barbatus, 467
Cymatoderma elegans, 461
Cynodon Dactylon, 277
Cynoglossum officinale, 39
Cynometra cauliflora, 271
Cyperus laevigatus, 275, 497, 500; pennatus, 276, 500; pheloides, 276; umbellatus, 277
Cypripedium hirsutum, 40
Cyrilla racemiflora, 150
Crytomium Fortunei, 98; Rochfordianum, 98
Cystopteris bulbifera, 207
Cyrtandra, 134

Dalibarda repens, 207
Dammara australis, 272
Danthonia spicata, 39
Datura Stramonium, 219, 277; Tatula, 219
Decodon verticillatus, 38
Dennstaedtia punctilobula, 366
Derris uliginosa, 270
Dictyocalyx Miersii, 270
Diervilla Lonicera, 38, 207
Digitalis grandiflora, 56; purpurea, 56
Dioclea violacea, 272
DODGE, B. O. Studies in the genus Gymnosporangium—II. Report on cultures made in 1915 and 1916, 287
Dodonaea, 271; viscosa, 270
Dougaldea Hoopesii, 153
Draba verna, 56
Drosera filiformis, 380; intermedia, 380; rotundifolia, 380
Drynaria composita, 285; quercifolia, 285
Dryopteris spinulosa, 40; Thelypteris, 39
Dryostachyum, 285
Dubautia laxa, 138
Dulichium arundinaceum, 39

Elaeodendron, 271
Eleocharis palustris, 40; tricostata, 372
Elymus sp., 33, 40
Encalypta affinis, 440; alaskana, 433, 435, 441; alpina, 435, 437, 440; apophysata, 435, 437, 443; brevicolla, 437, 438, 444; ciliata, 435, 441; ciliata microstoma, 442; commutata, 441; contorta, 434, 436–438, 445; cucullata, 433, 435, 436, 438, 444; extinctoria, 434, 437, 438; extinctoria apiculata, 439; extinctoria mutica, 439; lacera, 434, 435; laciniata, 434, 437, 441; laciniata **microstoma**, 440, 442; leiomitra, 435, 439, 440; leiocarpa, 433, 435, 436, 443; labradorica, 434, 435, 436, 444; longipes, 433, 435, 436, 444; Macounii, 433, 435, 443; mexicana, 435, 441; pilifera, 440; procera, 435, 438, 444; rhabdocarpa, 435, 437, 439, 440; rhabdocarpa microstoma, 440; rhabdocarpa pilifera, 440; Selwyni, 433, 435, 436, 444; streptocarpa, 436, 445; subbrevicolla, 434, 436, 444; subspathulata, 434, 435, 439, 440; vulgaris, 435, 438
Encalypta, Revision of the North American species of, 433
Entada scandens, 271
Epigaea repens, 40
Equisetum arvense, 39, 366; fluviatile, 40; hyemale, 33, 39; laevigatum, 40; palustre, 39; scirpoides, 40
Eragrostis hawaiiensis, 276, 500
Eriophorum viridicarinatum, 40
Erodium cicutarium, 382
Erysibe miniata Rosarum, 455; panicorum, 452
Erysimum cheiranthoides, 380
Erythraea sabaeoides, 276
Erythrina monosperma, 275
Euchlaena luxurians, 318; mexicana, 318, 332
Eupatorium, 154; perfoliatum, 39; purpureum, 39, 154
Euphorbia, 271; Atoto, 270; cordata, 275, 487, 495, 496; pilulifera, 277
Euthamia sp., 40
Euxolus viridis, 277, 500
EVANS, A. W. The air chambers of Grimaldia fragrans, 235
Evolution of maize, The, 309
Excoecaria Agallocha, 271
Exidia ampla, 456; auricula-judae, 457; nobilis, 456; tenuis, 457

Fagus grandiflora, 37, 375
Ferns and flowering plants of Nantucket—XIX, The, 365

FERRIS, R. S. Taxonomy and distribution of Adenostegia, 399
Festuca capillata, 371; myuros, 371; octoflora, 371; ovina, 371
Ficus macrocarpus, 52
Filicites meniscioides, 280
Fimbristylis pycnocephala, 274, 489
Fleurya interrupta, 276
Fomes albomarginatus, 464; carneus, 466; cornu-bovis, 465; Fullageri, 465; melanoporus, 465; Merrillii, 465; pyrrhocreas, 464; roseus, 465; spadiceus, 467, 468; substygius, 467
Fraxinus americana, 37; nigra, 37
Friesia, 477; argentea, 479

Galium triflorum, 40
Gaultheria procumbens, 39
Geoglossum, 79; glabrum, 80; glutinosum, 80
Geranium mexicanum, 156; Robertianum, 31, 40
Glyceria Fernaldii, 370
Gossypium tomentosum, 274, 495
GRAFF, P. W. Philippine Basidiomycetes—III, 451
Grimmia, 433
Grimaldia dichotoma, 236
Grimaldia fragrans, The air chambers of, 235
Guettarda speciosa, 271
Gymnadeniopsis clavellata, 374
Gymnosporangium clavariaeforme, 292; clavipes, 287, 293, 296; Ellisii, 287, 291, 293; fraternum, 296; globosum, 287, 288, 290; juvenescens, 294; macropus, 287, 288; nidus-avis, 287, 293, 294; transformans, 296
Gyromitra esculenta, 79; gigas, 80, infula, 79

Hamaspora acutissima, 454
HARPER, E. T. Two remarkable Discomycetes, 77
HARPER, R. M. The plant population of northern lower Michigan and its environment, 23
HARRIS, J. A., & AVERY, B. T. Correlation of morphological variations in the seedling of Phaseolus vulgaris, 109
Helianthus petiolaris, 383
Heliotropium, 271; anomalum, 275; curassavicum, 270, 275, 500
Helvella crispa, 79, 80; elastica, 79, 85; mesenterica, 455
Heritiera littoralis, 270
Herpestis Monnieria, 275
Hibiscus, 271; Rosa-sinensis, 276; tiliaceus, 270, 271, 276
Hicoria alba, 375; glabra, 375; microcarpa, 375
Hirneola affinis, 456; ampla, 456; auricula-judae, 456; nobilis, 456; tenuis, 457
Hordeum jubatum, 372; vulgare, 372
Houstonia caerulea, 383
HUMBERT, E. P. A striking variation in Silene noctiflora, 157
Humulus Lupulus, 378
Hydneae, 463
Hydrocotyle verticillata, 277
Hymenochaete adusta, 457; cacao, 458; nigricans, 458; rheicolor, 458; tenuissima, 458
Hymenolichenes, 461
Hyoscyamus niger, 219
Hypericum opacum, 480
Hypoxis hirsuta, 374

Ilex verticillata, 38
Impatiens pallida, 207
Index to American botanical literature, 43, 87, 121, 159, 211, 253, 301, 347, 385, 425, 470, 503
Indigofera Anil, 277
Ipomoea, 271; acetosaefolia, 275; glaberrima, 272, 275, 496; grandiflora, 271; insularis, 275, 496, 500; maritima, 270; pes-caprae, 270, 272, 275, 500
Iris versicolor, 29, 39
Irpex flavus, 463

Jacquemontia sandwicensis, 276, 495, 497
Juncus balticus, 373
Juniperus communis, 292; virginiana, 288, 366

Kadua littoralis, 274, 489, 495, 496
Kalmia polifolia, 28
Keerlia mexicana, 154
Koellia incana, 383
Krameria glandulosa, 143
Kyllingia monocephala, 276

Labordia, 134
Laburnum vulgare, 382
Lachnea semitosta, 80
Lachnocladium flagelliforme, 462; usambarense, 462
Lactuca virosa, 383
Laguncularia racemosa, 270
Larix decidua, 366; laricina, 37, 42
Laschia velutina, 456
Lathyrus odoratus, 56; palustris, 39
Lechea Leggettii, 480
Ledum groenlandicum, 38
Leotia, 79
Leersia alpina, 441; ciliata, 441; contorta, 445; extinctoria, 438; extinctoria pilifera, 440; laciniata, 441; marginata, 438; rhabdocarpa, 439; procera, 444; Selwyni, 444; vulgaris, 438
Lemna minor, 373; trisulca, 373
Lens esculenta, 56

Lepidium owaihense, 274, 487, 495, 496, 500
Leptemon lineare, 479
Leptilon canadense, 39
Lepturus repens, 275, 500
Leucaena glauca, 276
Lilium philadelphicum, 39, 373
Linnaea americana, 39
Linum angustifolium, 59, 70; striatum, 382; usitatissimum, 70
Liparis Loeselii, 374
Lipochaeta connata littoralis, 274; integrifolia, 274, 495, 500; succulenta, 274, 496
Liriodendron Tulipifera, 379
Lobelia cardinalis, 40; Erinus, 58, 59, 66; hypoleuca, 138; **oahuensis**, 137
Lonicera canadensis, 34, 38
Lumnitzera coccinea, 271; racemosa, 271
Lupinus affinis, 192; arenicola, 1, 2; brevicaulis, 11; Bridgesii, 1, 2, 20; densiflorus, 1–7, 167, 172, 174; densiflorus **altus**, 172, 185; densiflorus **austrocollium**, 173, 200; densiflorus **barbatissimus**, 173, 199; densiflorus **crinitus**, 173, 195; densiflorus **curvicarinus**, 173, 196; densiflorus **Dudleyi**, 173, 188, 189; densiflorus **glareosus** 172, 180; densiflorus **lacteus**, 172, 181; densiflorus **latilabrus**, 172, 178; densiflorus **latidens**, 173, 188; densiflorus **Menziesii**, 172, 176; densiflorus **McGregori**, 172, 184; densiflorus **palustris**, 173, 176, 191; densiflorus **perfistulosus**, 172, 175; densiflorus **persecundus**, 173, 190; densiflorus **Reedii**, 173, 197; densiflorus **scopulorum**, 173, 201; densiflorus **stanfordianus**, 173, 194; densiflorus **stenopetalus**, 172, 174; densiflorus **sublanatus**, 172, 183; densiflorus **Tracyi**, 172, 179; densiflorus **trichocalyx**, 173, 198; densiflorus **vastiticola**, 172, 186; densiflorus **versabilis**, 173, 187; glareosus, 1, 5, 14; horizontalis, 1, 5, 7, 11; horizontalis **platypetalus**, 12; lacteus, 1, 170; luteolus, 1–7, 20, 21; malacophyllus, 1, 2, 7; Menziesii, 1, 3, 170; Menziesii aurea, 1; microcarpus, 1–9, 200; microcarpus **ruber**, 10; palustris, 1; ruber, 1, 10; subvexus, 1, 5, 7, 12, 13, 193; subvexus **albilanatus**, 13, 19; subvexus **fluviatilis**, 6, 13, 14; subvexus **insularis**, 13, 17; subvexus **Leibergii**, 13, 16; subvexus **nigrescens**, 13; subvexus **phoeniceus**, 13, 17; subvexus **transmontanus**, 8, 13, 15; subvexus **Wilkesii**, 13, 20
Lupinus, Studies in the genus—II, 1; —III, 167
Lycium sandwicense, 274
Lycoperdon subcordatum, 454
Lycopersicum peruvianum, 270
Lycopodium annotinum, 39, 207; complanatum, 366; lucidulum, 207; obscurum, 366; obscurum dendroideum, 207; tristachyum, 366
Lysimachia spathulata, 275, 495; terrestris, 39
Lythrum maritimum, 276

MacCaughey, V. The strand flora of the Hawaiian Archipelago—I. Geographical relations, origin, and composition, 259;—II. Ecological relations, 483
Malvastrum tricuspidatum, 276
Matonia pectinata, 283
Medeola virginiana, 373
Menyanthes trifoliata, 40
Merulius affinis, 456; auricula, 456
Mesembryanthemum spp., 277
Metrosideros polymorpha, 276, 495; rugosa, 138
Michigan, The plant population of northern lower, 23
Mirabilis Jalapa, 56, 65
Mitchella repens, 39
Mitella nuda, 40
Morchella esculenta, 79, 80; hybrida, 79
Morinda, 271; citrifolia, 270, 271, 276
Mozinna spathulata, 152
Mucuna gigantea, 271, 272, 276; urens, 272
Myoporum sandwicense, 275
Myriadoporus adustus, 463
Myrica carolinensis, 375; Gale, 38, 374
Myriophyllum prosperinacoides, 482

Nama sandwicensis, 276, 495, 496, 500
Naias flexilis, 368; guadalupensis, 368
Naumburgia thyrsiflora, 40
Nemopanthes mucronata, 38
Nephrodium hirtipes, 98; molle, 94; pseudo-mas polydactylum, 98
New species of Hawaiian plants, 133
New species of Uredineae—X, 141
Nicotiana glauca, 220; glutinosa, 270; Tabacum, 219, 220, 221
Nigella damascena nana, 56, 65
Nipa fruticans, 270
Nishimura, M. A carrier of the mosaic disease, 219
Notes on plants of the southern United States—IV, 477
Notes on the fern genus Clathropteris, 279
Notholaena distans, 96; Eckloniana, 96; sinuata, 96
Nothoscordium, 149
Notoptera hirsuta, 149
Nototrichium humile, 274
Nymphaea alba, 52; variegata, 28, 39

Oenothera gigas, 53, 54, 58; Lamarckiana, 53, 54, 58

On the constancy of cell shape in leaves of varying shape, 51
Oncomyces mesentericus, 455
Onoclea sensibilis, 39
Ophioglossum vulgatum, 276, 365
Opuntia, 271· discata, 353; versicolor, 353
Oryzopsis asperifolia, 40
Osmunda cinnamomea, 94; Claytoniana, 94, 365; regalis, 94, 39, 103, 104; spectabilis, 365
Ostrya virginiana, 37
Oxycoccus macrocarpus, 40

Pandanus odoratissimus, 276
Pangium edule, 270
Panicularia acutiflora, 370; americana, 370; grandis, 370; pallida, 370; pallida Fernaldii, 370
Panicum Addisonii, 368; Bicknellii, 369; depauperatum, 40, 368, 369; dichotomum, 369; linearifolium, 368; meridionale, 369; Owenae, 368, 369; sanguineum, 56; tennesseense, 369
Pariera, 270
Pastinaca sativa, 39
Pellaea adiantoides, 96, 99; atropurpurea, 96, 99, 102; atropurpurea cristata, 96; cretica, 99; flavens, 96; nivea, 96; tenera, 96; viridis, 99
Pemphis acidula, 270, 271
PENNELL, F. W. Notes on plants of the southern United States—IV, 477
Pentstemon procerus, 143
Persicaria pensylvanica, 378
PETRY, L. C. Studies on the vegetation of New York State—II. The vegetation of a glacial plunge basin and its relation to temperature, 203
Petunia violacea, 219
Peucedanum sandwicense, 276
Peziza auricula, 456; coronaria, 84; coronaria macrocalyx, 85; Stevensoniana, 84; vesiculosa, 84
Phalaris arundinacea, 40
Phaseolus vulgaris, 56
Phaseolus vulgaris, Correlation of morphological variations in the seedling of, 109
Phegopteris Dryopteris, 207
Phegopteris polypodioides, Regeneration in, 391
Philippine Basidiomycetes—III, 451
Phlebia mesenterica, 455; reflexa, 456; rugosissima, 456
Phleum pratense, 40
Phragmidium Rosarum, 455; Rosae pimpinellifoliae, 455; subcorticium, 454
Phyllostegia variabilis, 274, 500
Physalacria orinocensis, 462
Physalis Alkekengi, 220, 231
Phytolacca decandra, 155
Picea canadensis, 37, 42; mariana, 28, 37, 42
Pinus Banksiana, 33, 37, 42; insularis, 464; resinosa, 37, 42; rigida, 366; Strobus, 37, 42; sylvestris, 51
Pisum sativum, 56, 65
Plant population of northern lower Michigan and its environment, The, 23
Plantago lanceolata, 59, 68; major, 59, 68; tomentosa, 270
Platycarpos, 1
Pleurotus flabellatus, 451
Poa pratensis, 38, 370
Polygonatum biflorum, 40, 373
Polygonum alpinum, 142; barbatum, 452; chinense, 452; maritimum, 378; pensylvanicum laevigatum, 378; pensylvanicum nesophilum, 378
Polypogon littoralis, 275, 497
Polyporus adustus, 463; albomarginatus, 464; atypus, 463; benguetensis, 464; Burtii, 463; carneus, 466; carpinus, 463; cinereo-fuscus, 465; crispus, 463; dolosus, 466; Elmeri, 468; flavus, 463; Halesiae, 463; incarnatus, 466; kermes, 464; laeticolor, 464; Lindheimeri, 463; luzonensis, 464; melanoporus, 465; ochrocroceus, 464; pallescens, 463; roseus, 466; rufo-pallidus, 466; spadiceus, 467; subcinereus, 463; tabacinus, 467
Polyporeae, 463
Polystictus abietinus, 466; atypus, 464; barbatus, 467; benguetensis, 464; cervino-gilvus, 463; microcyclus, 467; perpusillus, 466; rubritinctus, 466; spadiceus, 467; substygius, 467; tabacinus, 467; tabacinus **barbatus**, 467; tabacinus **substygius**, 467; xerampelinus, 467
Pongamia glabra, 270
Populus balsamifera, 37; grandidentata, 33, 37; tremuloides, 33, 37
Portulaca oleracea, 277, 500
Potamogeton Oakesianus, 367; pectinatus, 367; pulcher, 367
Potentilla Anserina, 33, 39
Primula sinensis, 55
Pritchardia Gaudichaudii, 500; spp., 276
Prosopis juliflora, 276, 489
Prunus maritima, 381; pennsylvanica, 33, 37; pumila, 33
Pteris aquilina, 38, 94; argyraea, 97, 102; cretica albolineata, 96, 97, 101, 102; Droogmantiana, 96; Parkeri, 97; quadriaurita argyraea, 96; serrulata, 94, 97; sulcata, 96, 97, 102
Puccineae, 454
Puccinia **adducta**, 148; Agropyri, 146; Ciberti, 454; cohaesa, 146; Eriophori, 144; **Heliconiae**, 144; Hyptidis, 454;

incondita, 148; **missouriensis**, 146; **Notopterae**, 149; **obesispora**, 147; patruelis, 150; **Rosenii**, 144; **Viornae**, 145; **wyomensis**, 143; Rivinae, 155
Puccinellia distans, 371; distans tenuis, 371
Pustularia gigantea, 82, 84; vesiculosa, 84
Pyrola asarifolia, 207
Pyropolyporus albomarginatus, 465; Merrillii, 465

Quercus alba, 31, 37, 42; alba x rufescens, 377; bicolor, 378; borealis maxima, 37, 42; coccinea, 375; coccinea x velutina, 378; ilicifolia, 376; ilicifolia x velutina, 377; pagodaefolia, 376; palustris, 378; prinoides rufescens, 376; **rufescens**, 376; stellata, 376; velutina, 40, 375

Radicula palustris, 380
Raimannia Drummondii, 482
Ranunculus recurvatus, 147; repens, 379
Razoumofskya pusilla, 28
Reana luxurians, 318
Regeneration in Phegopteris polypodioides, 391
Relationship between the number of sporophylls and the number of stamens and pistils—a criticism, The, 343
Reseda lutea, 380
Revision of the North American species of Encalypta, 433
Rhachicallis, 271
Rhamnus alnifolia, 34, 38
Rhexia Alifanus, 482; aristosa, 482; cubensis, 481; delicatula, 481; **interior**, 480, 482; lanceolata, 484; latifolia, 480; lutea, 480, 481; mariana, 481; Nashii, 480, 482; parviflora, 481; petiolata, 481; serrulata, 481; stricta, 482; virginica, 482
Rhizomopteris cruciata, 281
Rhizophora, 271
Rhus, 271; glabra, 38, 42; sp., 38: Toxicodendron, 33, 38, 42
Ribes lacustre, 207, 209
Riccia fluitans, 243; Frostii, 243, 244; glauca, 245; natans, 243
Ricciocarpus natans, 243
Ricinus communis, 271
ROCK, J. F. New species of Hawaiian plants, 133
Roestelia transformans, 287
Rollandia **angustifolia**, 136; longiflora, 137
Rosa cinnamomea, 380; sp., 33, 38
Rubus allegheniensis, 38, 42; odoratus, 207; strigosus, 38, 42; triflorus, 39
Rumex crispus, 378; elongatus, 378; maritimus fueginus, 378; persicarioides, 378
Ruppia maritima, 271, 275, 367, 497
Rynchospora aurea, 453; glauca, 453

Sabbatia campanulata, 383; stellaris, 383
Sagus, 271
Salix Bebbiana x cinerea, 374; discolor, 38; fluviatilis, 37; lucida, 37; pedicellaris, 34; petiolaris, 374; rostrata, 38; Smithiana, 374; spp., 37
Sagittaria Engelmanniana, 368; latifolia, 368
Salsola Kali, 492
Salvia occidentalis, 277
Samanea Saman, 277
Sambucus pubens, 34, 38
Santalum Freycenetianum littorale, 274, 487, 489, 500
Sapindus Saponaria, 271
Sassafras Sassafras, 380
Scaevola, 271; coriacea, 274; Koenigii, 271, 272; Lobelia, 275, 500; Plumieri, 270
Schiedea globosa, 274, 495; Lydgatei, 274, 495
Schoenus nigricans, 144
Scirpus americanus, 39; 144, atrovirens, 40; cyperinus pelius, 39; maritimus, 275; validus, 39, 372
Scolopendrium vulgare, 203
Scyphiphora hydrophyllacea, 271
Sepultaria sepulta, 84
Sesbania tomentosa, 275
Sesuvium, 271; Portulacastrum, 275, 496, 489, 500
Setiscapella subulata, 383
Sicyos hispidus, 276, 495, 500; microcarpus, 276, 500
Sida spp., 495
Silene noctiflora, A striking variation in, 157
Sistotrema violaceum, 466
Smilax herbacea, 373
SMITH, C. P. Studies in the genus Lupinus—II. The Microcarpi, exclusive of Lupinus densiflorus, 1;—III. Lupinus densiflorus, 167
Solanum aculeatissimum, 219, 221–231; carolinense, 219; laysanense, 274, 500; Nelsoni, 274; nigrum, 219; racemosum, 148; triquetrum, 148; tuberosum, 56
Solidago, 271; canadensis, 38
Sonneratia sp., 271
Sophora tomentosa, 271
Sparganium americanum, 367; eurycarpum, 367
Spartina Michauxiana, 39, 271
Spathularia, 79
Spiraea latifolia, 38
Spongipellis luzonensis, 464
Sporobolus, 271; argutus, 155; virginicus, 275, 489, 500; virginicus phleoides, 274

STEIL, W. N. Studies of some new cases of apogamy in ferns, 93
Stereum adustum, 457; bellum, 458; cacao, 458; concolor, 459; contrarium, 460; crenatum, 459; involutum, 459; lobatum, 459; lugubre, 459; luzoniense, 460, 461; nigricans, 458; ostrea, 459; ostrea concolor, 459; perlatum, 459, 460; princeps, 460; radio-fissum, 460; rheicolor, 458; scytale, 460; spectabile, 460; tenuissimum, 458
Stevia sp., 154
Stipa avenacea, 369
Strand flora of the Hawaiian Archipelago, The,—I. Geographical relations, origin, and composition, 259;—II., Ecological relations, 483
Straussia **glomerata** 138; hawaiiensis, 134, 139
Striking variation in Silene noctiflora, A, 157
Streptopus roseus, 207
Strongylodon, lucidum, 134, 271, 272
Studies in the genus Gymnosporangium —II., Report on cultures made in 1915 and 1916, 287
Studies in the genus Lupinus—II. The Microcarpi, exclusive of Lupinus densiflorus, 1;—III. Lupinus densiflorus, 167
Studies of some new cases of apogamy in ferns, 93
Studies on the vegetation of New York state—II. The vegetation of a glacial plunge basin and its relation to temperature, 203
Suriana maritima, 270 271
Stenotaphrum, 271

Tacca pinnatifida, 271
Targionia hypophylla, 244, 246
Taxonomy and distribution of Adenostegia, 399
Taxus canadensis, 38, 42
TENOPYR, L. A. On the constancy of cell shape in leaves of varying shape, 51
Tephrosia littoralis, 270; piscatoria, 275
Terminalia Katappa, 271
Tetramolopium sp., 495, 496
Thalictrum dasycarpum, 39; polygamum, 380
Thelephora adusta, 457; atro-caerulea, 457; caerulea, 457; concolor, 459; fimbriata, 457; indigo, 457; lobata, 459; mesenterica, 455; nigricans, 458; purpurea, 455; pavonia, 462; princeps, 460
Thelephoreae, 457
Thenardia Galeottiana, 150
Thespesia populnea, 270, 271, 497
Thuja occidentalis, 37
Thymus serpyllum, 383
Tiarella cordifolia, 207
Tilia americana, 37
Tilletia destruens, 452; Oryzae, 453
Tithymalus commutata, 151; leiococcus, 151; missouriensis, 151; robusta, 151
Tournefortia argentea, 270, 271
Tradescantia virginiana, 373
Trametes aurora, 463; Elmeri, 468; insularis, 468
Tranzschelia cohaesa, 146
Trematolobelia macrostachys, 138
Tremella caragana, 456; auricula, 456; auriformis, 456
Triadenum virginicum, 39
Tribulus cistoides, 270, 276, 495, 500
Trientalis americana, 39
Trifolium pratense, 40; repens, 40
Triglochin maritima, 368
Trillium grandiflorum, 40
Tripsacum dactyloides, 323
Tsuga canadensis, 37
Typha angustifolia, 366; latifolia, 29, 38, 367
Tyromyces Elmeri, 468
Two remarkable Discomycetes, 77

Ulmus americana, 37, 42
Underwoodia columnaris, 77
Unifolium canadense, 38
Uredo carbo, 452; Ciberti, 454; destruens, 452; **egenula**, 155; Eglanteriae, 455; elevata, 454; Heliconiae, 144; Hyptidis, 454; miniata Eglanteriae, 454; **panamensis**, 155; tonkinensis, 453; **unilateralis**, 155
Uromyces Acetosae, 143; **Atriplicis**, 141; **fuscatus**, 142, **Krameriae**, 143
Urtica dioica, 56
Ustilagineae, 452
Ustilago Adropogonis-aciculati, 452; carbo destruens, 452; destruens, 453; emodensis, 452; Koordersiana, 452; leucoderma, 453; Panici miliacei, 452; tonkinensis, 453; virens, 453
Ustilaginoidea Oryzae, 453; virens, 453

Vaccinium canadense, 38; pennsylvanicum, 38
Vagnera racemosa, 31, 39; stellata, 373; trifolia, 39
Verbascum Thapsus, 39
Verbena littoralis, 270; polystacha, 270
Verpa digitaliformis, 79
Vibrissea, 79
Viburnum acerifolium, 31, 38; cassinoides, 38; venosum, 383
Victoria regia, 52
Vigna, 271; lutea, 270, 272, 276; oahuensis, 270
Vitex trifolia, 272

Vitis vinifera, 52, 271; vulpina, 38

Waltheria americana, 276, 497
Washingtonia Claytoni, 39
WEATHERWAX, P. The evolution of maize, 309
Wikstroemia Uva-ursi, 274, 496
Wollastonia glabra, 270, 271
Wound periderm in certain cacti, 353

Xanthium echinatum, 277
Ximemia americana, 271

Zanichellia palustris, 368
Zea canina, 309, 329; Mays, 56, 312
Zostera, 271

AN ILLUSTRATED FLORA

OF THE

NORTHERN UNITED STATES, CANADA, AND THE BRITISH POSSESSIONS

From Newfoundland to the Parallel of the Southern Boundary of Virginia, and from the Atlantic Ocean Westward to the 102d Meridian

By

NATHANIEL LORD BRITTON, Ph.D., Sc.D., LL.D.

Director-in-Chief of the N. Y. Botanical Garden; Professor in Columbia University

And

HON. ADDISON BROWN, A.B., LL.D.

President of the New York Botanical Garden

Three Volumes. $13.50 Special Net; Expressage extra

SECOND EDITION—REVISED AND ENLARGED

CHARLES SCRIBNER'S SONS

FIFTH AVENUE AT 48th STREET NEW YORK

American Fern Journal

An illustrated quarterly devoted to the general study of ferns. Subscription, with membership in the AMERICAN FERN SOCIETY, $1.00 per annum; without membership, 90 cents. Volume I, six numbers, $2.00; other volumes, $1.00 each. Matter or publication should be sent to R. C. BENEDICT, 322 East 19th Street, Brooklyn, N. Y.; subscriptions and other business communications to E. J. WINSLOW, Auburndale, Mass.

THE BRYOLOGIST

THE ONLY MAGAZINE IN THE WORLD RELATING EXCLUSIVELY TO THE STUDY OF MOSSES, HEPATICS, AND LICHENS

Illustrated with original drawings and half-tones. Twenty-first volume begins with January, 1918. Send for sample copy; subscription price $1.25 per year. Address

EDWARD B. CHAMBERLAIN,

18 West 89th Street, NEW YORK CITY.

Large Dissecting Stand

A new design which meets every requirement by reason of its large size and wide range of usefulness. Accommodates interchangeably Binocular Microscope body (illustrated), Monocular Erecting Body, using medium high power objectives, or simple lens in jointed arm—all focused by rack and pinion. The microscope bodies may be mounted on a sliding track, permitting the entire width of the stage to be covered.

Stage, 8 x 7 inches, is provided with glass and metal plates, 4¼ inches in diameter, and with adjustable background stops beneath.

With 38 and 19 mm. doublet lenses $26.50

With Binocular Microscope body, 40 mm. objectives and 10X eyepieces, as illustrated above $70.00

Write for illustrated circulars.

Bausch & Lomb Optical Co.

NEW YORK WASHINGTON CHICAGO SAN FRANCISCO
LONDON ROCHESTER, N.Y. FRANKFORT

ADDISONIA

A quarterly journal containing beautiful colored illustrations and popular descriptions of plants.

Published by the New York Botanical Garden, Bronx Park.

Supported by the income of a bequest by the late Judge Addison Brown, aided by subscriptions.

The second volume has recently been completed; the third volume will be issued during 1918; each volume contains 40 full-page colored illustrations.

Additional subscriptions, for the whole work only, are invited at $30, being $10 per volume. Sample parts will be mailed on request.

NEW YORK BOTANICAL GARDEN BRONX PARK NEW YORK CITY

NATIONAL PHOTO-ENGRAVING Co.
46-48 NEW CHAMBERS STREET
NEW YORK, N. Y.
ENGRAVERS FOR THE BULLETIN
OF THE
TORREY BOTANICAL CLUB
AND A NUMBER OF SCIENTIFIC PUBLICATIONS

SOIL SCIENCE

JACOB G. LIPMAN
Editor-in-Chief

A monthly journal devoted to the broader outlook of the entire field of soil fertility. Articles dealing with the more important facts, observations, deductions and problems of soil biology, soil chemistry, and soil physics are published. Papers devoted to plant physiology, agronomy, bacteriology, or geology, are accepted for publication if they contribute directly to the knowledge of soil fertility. The study of the mineral and organic constituents of soils, soil gases, soil water as a solvent of soil material, soil colloids, the transformation of commercial plant-foods in soils, questions that deal with the fundamental facts of soil fertility and productivity are given due consideration. The phenomena concerning soil micro-organisms, such as bacteria, molds, protozoa, and algae, receive careful attention.

Published monthly. Two volumes (1000 pages) a year are issued. Illustrated. Price, Vols. V and VI (1918), $5.00 domestic; $5.50 foreign. Back volumes, I-IV incl., per volume, $3.00 domestic; $3.50 foreign. Send for Contents Bulletin.

Order from

WILLIAMS & WILKINS COMPANY
PUBLISHERS **BALTIMORE, U. S. A.**

MEMOIRS OF THE TORREY BOTANICAL CLUB

A series of technical papers on botanical subjects published at irregular intervals. Price $3.00 a volume. Not offered in exchange.

Vol. 8, No. 1; not furnished separately:

Lloyd, Francis Ernest. The comparative embryology of the Rubiaceae. Part I. Pages 1–26, *plates 1–4*. 26 Au 1899. Part II. Pages 27–112, *plates 5–15*. 15 F 1902.

Vol. 8, No. 2; price, $1.00:

Evans, Alexander William. The Lejeuneae of the United States and Canada. Pages 113–183, *plates 16–22*. 15 F 1902.

Vol. 8, No. 3; price, 75 cents:

Britton, Elizabeth Gertrude, & Taylor, Alexandrina. The life history of *Vittaria lineata*. Pages 185–211, *plates 23–31*. 30 Au 1902.

Vol. 9; price, $3.00:

Salmon, Ernest Stanley. A monograph of the Erysiphaceae. Pages 1–292, *plates 1–9*. 4 O 1900. No longer sold except in complete sets of the Memoirs.

Vol. 10; price, $3.00:

Burgess, Edward Sandford. History of Pre-Clusian botany in its relation to *Aster*. Pages i–xii, 1–447. 22 N 1902.

Vol. 11, No. 1; price, $1.75:

Griffiths, David. The North American Sordariaceae. Pages 1–134, *plates 1–19*. 30 My 1901.

Vol. 11, No. 2; price, $1.75:

Hazen, Tracy Elliot. The Ulothricaceae and Chaetophoraceae of the United States. Pages 135–250, *plates 20–42*. 20 O 1902.

Vol. 12, No. 1; price, $1.50:

Northrop, Alice Rich. Flora of New Providence and Andros (Bahama Islands). Pages 1–98, *plates 1–19+map*. 10 D 1902.

Vol. 12, No. 2; price, $1.00:

Banker, Howard James. A contribution to a revision of the North American Hydnaceae. Pages 99–194. 13 Je 1906.

Vol. 12, No. 3; price, 75 cents:

Kupfer, Elsie. Studies in plant regeneration. Pages 195–241. 10 Je 1907.

Vol. 13; price, $3.00:

Burgess, Edward Sandford. Species and variations of Biotian Asters, with discussion of variability in *Aster*. Pages i–xv, 1–419, *plates 1–13*. 15 Mr 1906.

Vol. 14, No. 1; price, $1.25.

Burlingham, Gertrude Simmons. A study of the Lactariae of the United States. Pages 1–109, *figures 1–15*. 26 My 1908.

Vol. 14, No. 2; price, 75 cents:

Butler, Ormond. Observations on the California vine disease. Pages 111–153, *plates 1–5*. 18 Je 1910.

Vol. 14, No. 3; price, $1.25:

Chivers, A. H. A monograph of the genera *Chaetomium* and *Ascotricha*. Pages 155–240, *plates 6–17*. 10 Je 1915.

Vol. 15; price, $3.00:

Howe, Marshall Avery. The marine algae of Peru. Pages 1–185, *plates 1–66+figures 1–44*. 19 S 1914.

Vol. 16, No. 1; price, $1.00:

Pickett, F. L. A contribution to our knowledge of *Arisaema triphyllum*. Pages 1–55, *plates 1–5*. 13 Au 1915.

Vol. 17; price, $5.00:

Proceedings of the Semi-centennial Anniversary of the Torrey Botanical Club. Pages 1–490, *plates 1–15*. 1918.

For contents of **Volumes 1–7** and for further information about the **Memoirs**,

Address **Dr. BERNARD O. DODGE**

Dept. of Botany, Columbia University New York City